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Developing Integrated
Waste Management
Strategies:
Information Needs and the
Role of Locally-Based Data

Integrated Waste Systems
The Open University

Developing Integrated Waste Management Strategies: Information Needs and the Role of Locally-Based Data

Report Prepared for
The Onyx Environmental Trust

Integrated Waste Systems
The Open University
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Views expressed in this report are those of the authors, and not necessarily those of The Open University or of The Onyx Environmental Trust.

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Executive Summary

Introduction

The management of municipal waste in the UK is currently going through a period of considerable and rapid change, with EU and UK government initiatives being significant drivers in this changing environment. Alongside these drivers, existing infrastructure and waste management systems, financial constraints, political climate and influences (particularly locally but also nationally and internationally), social and technical issues, knowledge, contacts and prejudices will all play a part in shaping local authority waste management strategic planning. Balancing these often-conflicting demands, and planning in an integrated way for sustainable waste management, is a major challenge faced by local authorities today.

This Report is aimed at helping authorities face this challenge by showing how recognising and responding to strategy information needs combined with the use of locally-based data can promote effective waste strategy planning. Indeed the importance of generating sound data which are based on local conditions and which are truly relevant to local needs is a key element in this work. The Report is intended as a guide, highlighting ways in which research can inform the process of developing integrated waste strategies. It illustrates improvements that could be achieved by using better data and analyses to inform decision making.

Integrated waste management (IWM) describes an approach in which decisions on waste management take account of different waste streams, collection, treatment and disposal methods to achieve a balance between collection and treatment methods that strives for environmental sustainability, cost effectiveness and social acceptability. This integration is beginning to be taken a step further in considering waste management as a part of a wider resource management system, and moving towards identifying wastes as potential resources.

Part One reviews waste strategy planning and source segregation in the UK. This identifies the type of information and analyses, used by authorities in current approaches to waste strategy planning. It reviews source segregation, including bring and kerbside collections, and introduces the important features of these prior to exploring the impacts of their different contributions in later Chapters.

Part Two comprises a number of Chapters that detail different types of information and analyses that can or should be included in assessing future options to determine strategies for IWM. These include scenario building, geographical information systems, compositional analysis and residual waste composition, combined with the importance of relevant local data and how it might be gathered, so that local data provides local answers. The general principals and methodologies of each approach are illustrated by case study examples derived from our analysis and interpretation of data provided by our case study partners, Project Integra. Project Integra is the partnership in Hampshire between the eleven district councils, Portsmouth and Southampton unitary authorities, Hampshire County Council, and the private waste contractor Hampshire Waste Services.

Good information is essential to underpin waste strategy planning and to plan for sustainable and integrated waste management. To make informed decisions strategy planners need to be able to evaluate options, and to do this they need to understand and meet local information, data and analyses needs, as well as assess how realistic the relative options are in meeting their objectives. Much past and current strategy planning in waste management is not based on thorough analysis. There is a pressing need for good, reliable detailed local information and data on waste arisings for local authorities to be able to plan realistically to meet specific targets.

Part One

Building Local Authority Waste Strategy Plans

This review of strategy planning in the UK in 2002 is not a survey but an indication of the current state of play. Chapter 2 reviews a selection of plans from 20 authorities across England; and comments on some plans in Scotland (3 Strategy Area Groups) and some international examples of strategy planning. The focus was to identify how these local authorities used data in their planning and decision-making, and also the nature of the data that is included in the selection of strategy documents.

The UK Government, Scottish Parliament and National Assembly for Wales have published a number of documents related to developing both national and local waste strategies for the future management of municipal wastes. This review also explores issues around the kinds of advice being provided by national government agencies, and whether and how these have been taken up at a local level in those strategies considered.

DEFRA (Department for Environment, Food and Rural Affairs) guidance says that Municipal Waste Management Strategies will need to demonstrate that the authority intends to meet their targets and how they will do this – but not necessarily to show the basis on which these proposals were derived. It mentions the need to identify and analyse the available options, but doesn't say that the authorities have to use and analyse data to support their proposals.

In summary examining the question of how local authorities used data to support and justify policy decisions, this review of UK waste management strategy documents found the following main issues:

- most authorities did not cover the criteria set out by DEFRA in its guidance on what should be included in Municipal Waste Management Strategies, with all of the documents examined containing an incomplete set of data by this standard;
- most authorities referred to the problems and barriers they face in meeting government targets and in their waste management planning, and these often included a lack of data with a number of authorities referring specifically to their need for better data;
- some mentioned the need for a change in the structure of waste management planning – referring to the current situation as fragmented and lacking coherent overall policy, creating a key dilemma for WCAs developing their strategy without the context of a disposal strategy from their WDA, or likewise for WDAs without the regional context;
- contractual arrangements already in place can limit an authority's ability to successfully plan for sustainable and integrated waste management;
- only 12 of the areas reviewed in England included detailed data on wastes dealt with by different collection methods including residual waste collections, kerbside recycling, bring systems and CA site wastes;
- only 10 of the reports considered referred to local studies of waste composition involving sampled surveys of collected household waste; of these only 2 referred to analyses of CA site wastes, showing the need for clear universal reporting protocols on waste arisings data;
- little attempt was made by authorities to integrate collected waste data with that on waste and recyclable materials collected through CA and bring sites, even though such a picture is critically important in planning collection methods and infrastructure to provide an integrated approach to meeting targets;
- very few authorities considered public participation (either in terms of how many participate or how effectively they capture targeted materials) in their planning documents,

or acknowledged the need to use data on participation and capture rates, with locally-based compositional data for the whole household or municipal waste stream, to identify where improvements could be made, and to plan more effectively;

- as few as four authorities included data on capture rates for recycling;
- few strategies included specific analysis of how their proposals would achieve improved recycling rates or meet their targets;
- most mentioned taking into account a number of factors including not only cost, but ability to meet Best Value targets, to satisfy political or social considerations, the overall environmental impacts, and seeking the Best Practicable Environmental Option (BPEO), although it was rare to find an authority which attempted to integrate these multiple criteria in its decision making process;
- many mentioned identifying the waste management system that is the BPEO, but it was rarely assessed, and where it was the assessment was often limited to using WISARD to compare treatment options.

The answer to the question “to what extent does understanding of waste stream and waste composition determine strategy planning?” according to the findings of this study must be very little.

Although every waste management authority included in this research used the term *integrated* repeatedly, this was not necessarily reflected in practice in an integrated approach to either the planning process or the systems proposed to provide the future basis for waste management in their area. The majority of strategy plans considered, even those that considered identifying the BPEO as an aim, based their priorities on the ‘Waste Hierarchy’. The simplicity of approach this offers, and the fact that priorities can be set without the need for extensive information concerning the waste stream being dealt with and the fairly universal acceptance of the ‘Hierarchy’ as offering the preferred environmental solutions, explains its popularity.

However focusing on the waste hierarchy has considerable drawbacks as an approach to integrated waste management. By generating and utilising locally-based information it should be possible to move forward to consider more complex models for evaluating combinations of processes to optimise the treatment of the whole waste stream, taking into consideration interactions between the demands and requirements of each option. The use of scenario building in order to evaluate and compare options is one effective way to make better use of available data. Identifying the waste management system that is the BPEO for the area through LCI and cost evaluation also offers a more integrated approach. This allows a more thorough assessment of environmental impacts, but equally can be of limited value as the BPEO can only be reliably identified if relevant information and particularly locally accurate data is available to carry out the LCI analysis.

Source Segregation, Bring and Kerbside Collections

Source segregation of municipal waste is an important component for planning and delivering Integrated Waste Management (IWM). It is considered a “necessity” to meet recycling and composting targets. In this light, Chapter 3 provides a background and review, which details general factors affecting source segregation and collection schemes and which should be considered when designing such schemes. A number of these factors are developed in the context of gathering and utilising locally based data for planning integrated waste management strategies in Part 2 of this Report, including understanding public participation, gathering

compositional data, modelling residual waste streams, building scenarios and illustrating a standard cost methodology.

Securing public participation in source segregation is an important element for successful schemes. Participation in segregation and collection schemes is subject to a complex range of factors, and there is little consensus on the prime determinants of recycling behaviour.

Despite the widespread adoption of bring systems, participation tends to be lower than in kerbside collection systems. Participation is particularly difficult to measure for bring schemes, but where it has been assessed average participation rates have been found in the range of 16% and 39%, and with accessible high density schemes up to 70%. Kerbside schemes exhibit an even wider range of measured participation rates with figure quotes from below 30% to almost 100%, with a mean rate of 63% evaluated in a DETR Good Practice Guide.

A frequently cited factor constraining recycling activity is inconvenience. To secure participation it is important that collection schemes are designed to be as convenient as possible. Studies in the US and Europe suggest that participation is encouraged through convenience factors such as container provision, collection frequency and communication strategies and information provision.

Many North American and European states have legally enforceable requirements to separate household recyclables and/or organics at source. The literature shows that mandatory kerbside schemes achieve higher levels of participation and material recovery than voluntary schemes. Direct variable charging, where householders are charged according to the amount of waste they produce, is well established in many areas overseas, and experience suggests that variable charging designed to encourage participation in recycling dramatically increases source segregation and recycling rates.

Part Two

Geographical Information Systems and their Potential Application for Informing and Delivering Waste Management Strategies.

Chapter 4 reviews the current use of GIS in public service delivery, and gives examples of the potential usefulness and application of GIS techniques for developing waste strategy plans, and in enhancing waste service provision and delivery. GIS is spatial data processing for the management of information about a particular environment, and relevant to public service delivery as much of this involves decisions about spatial or location factors.

Over the past few years there has been increased use of GIS in decision making for public service provision. In partnership agreements with OS, all central government and local authorities have access to digitized map data for their particular area, onto which they can map their own data for illustrative and analysis purposes. The largest growth area in GIS use is in land-use planning, transport and health provision, and to-date there has been limited use of GIS for waste management and recycling.

This Chapter outlines the nature and underlying principles of GIS, and discusses some of the potential applications GIS could have for waste management and recycling. The Report cites applications including data storage, monitoring and analysis at the national, regional and local level. Local authorities' waste strategies need to be based on a detailed understanding of waste arising, composition and flows. GIS could be used to advance this understanding and to provide a framework for developing waste and recycling strategies. GIS provides a powerful

tool for communicating a large amount of data at a glance. Over the last few years DEFRA have included GIS produced maps for illustrating their household municipal waste statistics.

The Report found a range of applications where using GIS could enhance waste strategy planning and these are described briefly here.

- The most common use of GIS in relation to managing waste is for *site selection*. The first step involves identifying siting factors, which are likely to include geology, transport networks, nature conservation area and demographics. The Report included as an example one application which used travel times to estimate accessibility to existing civic amenity sites in South Norfolk, which highlighted areas furthest from the sites in terms of minutes travelled and thus potential locations for additional sites.
- GIS can be used for a range of *waste monitoring purposes*. For individual landfill site, GIS can be used to outline the void space, to calculate lining requirements, to calculate volumes of individual cells, and identify appropriate leachate and gas monitoring locations. GIS allow spatial patterns of pollutants to be modelled, and data on pollutant concentrations and population distribution to be combined and analysed. GIS can be used to monitor and model pollutant and particle matter from any waste or recycling plant, such as emissions from Energy from Waste plants, and bioaerosols from composting plants.
- GIS has a number of potential applications in relation to *waste collection and transport*. In an integrated approach to the transport of waste, the optimum mode for a given journey may be determined. An example cited is of a project which aims to provide a tool for the planning system to ensure that waste management facilities can be located to minimise journey distances and emissions. GIS is a valuable tool for route planning, and can be used to improve waste and recycling collection efficiency.
- Bring and CA site data, kerbside collection data, population characteristics and recycling behaviour by area could be mapped and used to determine any correlation such as between recycling behaviour and access to recycling facilities, as shown in an example developed from recycling participation data for a London borough.
- New participatory approaches to GIS are emerging, referred to as public participation geographic information systems (PPGIS) and involve the integration of conventional spatial data with mental maps, showing communities (or different groups) perceptions of their environment and how they use resources.

One of the drawbacks of GIS is their expense, in terms of professional software systems, technical know how and relevant data. However, most local authorities already have the software systems in place, which are increasingly accompanied by dedicated technical personnel. Whilst expanding GIS use within local authorities to encompass waste and recycling services will undoubtedly require additional resources in terms of expertise, the bulk of the software and technical resources needed are already in place. Some data, such as quantities collected from specific bring or civic amenity sites could be spatially referenced and incorporated into GIS with minimal effort, using either unit postcodes or a geographical positioning system. If the GIS use in waste management is to develop, it is important that spatial requirements are considered at the data collection design stage.

Understanding Public Participation When Developing Strategy Plans

The role of public participation – both in terms of numbers and how effectively materials are captured – in improving recycling performance is explored in Chapter 5. It clearly shows the importance of local data on participation, and the calculation of locally relevant capture rates as significant differences can arise at sub-district levels as well as between districts.

An understanding of public participation needs to play a key role in strategic planning, not only in assessing the current performance of recycling schemes but also in identifying where to target improvements and determining the potential for improvement.

Knowing how many people participate, and the accurate location of participating households, can inform campaigns to increase participation. Knowing how well people understand how to participate in a scheme and what they choose to do about it is invaluable evidence for local authorities in identifying where and how to target public information campaigns and effectively improve the quality of participation.

The effective monitoring and evaluation of kerbside recycling schemes should involve the close integration of different categories of data, including questionnaire data on public understanding. The research found that only when performance data are analysed together with social survey data does a complete picture emerge of how public understanding influences scheme performance. Where this is the case, performance improvements can be better planned and limited resources will be used more effectively as promotional campaigns can be more accurately targeted.

The Report concludes that those aspects of participation that it is important to measure include:

- Numbers participating – both the overall participation rate (of households participating at least once in a four week period) and the set-out rate (the proportion of households putting materials out for collection in any one week)
- How effectively people are participating – measuring the amount of what is collected for recycling, the composition of the separated material, undertaking MRF sorts and calculating reject rates, can all tell how well people are separating their waste and how much of the available recyclables are being captured, but not why they are not participating fully
- Levels of public understanding – to probe why people do or do not effectively participate in particular schemes and how participation might be improved. This can be gained from analysis of public attitude surveys and public involvement strategies

A good example of research into public participation being used to improve performance in recycling collection schemes is cited in the Report and this involves an analysis of understanding about which materials could be separated for recycling amongst residents in Hampshire. The analysis identified a distinct lack of awareness in certain districts that magazines were collected for recycling. This information, together with data on what was being collected for recycling from different districts, informed a targeted publicity campaign by Hampshire CC to promote magazine recycling to the public in those areas. This targeted campaign was evaluated both for impact of the media and images used, and effect on recycled tonnage. It was found that in the period following the campaign that tonnage of recycled paper collected in the two targeted districts increased at least 12% in comparison with the rest of Hampshire.

The Report discusses other issues to emerge from the research concerning the relationship between ease of participation, the range of materials targeted, the degree of separation required by participants, how well the message is communicated, and the quality of participation achieved. Increasing the range of recyclables collected by a scheme without achieving a good level of understanding amongst participants will not lead to improved diversion. It concluded

from the results from the study of kerbside recycling in Hampshire, that how complicated the scheme is and how well the message is communicated were important factors in determining understanding.

Further research is needed to examine, compare and evaluate different communication strategies with a focus on how they impact on understanding and quality of participation, and to answering the question of whether communication, or making it easier for people to participate, is the key to improving understanding?

Compositional Data to Improve Strategy Planning

Chapter 6 describes the methodological approach that was developed during this research, to collecting and analysing waste composition data in a way that allows data collected from different household waste streams to be integrated to give a profile of the total municipal waste stream. Data integrated in this way will give a more accurate basis for evaluation of performance and planning to achieve recycling and other targets.

This methodology was subsequently used and extended as the basis of the analysis of national average household waste composition undertaken for the Cabinet Office's Strategy Unit, and from which data was later adopted and used in the WET (Waste Emissions Trading) Bill currently going through Parliament.

Local waste management strategies need to take into account all household waste arisings, including those taken to Civic Amenity sites and 'bring' facilities. The Report concluded that research that deals with one aspect of the household waste stream in isolation can build a misleading picture of the amount and type of waste produced by households in any particular area. This can prove a serious weakness in the development of realistic waste management scenarios, and lead to unrealistic choices for future strategy. This point is addressed in the Strategy Unit research paper on the analysis of household waste composition, which is introduced with the sentence "There is much confusion over the meaning and validity of household waste compositional statistics in the UK". It goes on to comment that "compositional studies in the UK have focused almost exclusively on establishing the composition of residual 'dustbin' waste" and consequently that 'dustbin' or collected refuse data is often misconstrued as representing the composition of all municipal waste arisings. And as a result "the lack of credible national estimates (for waste composition) has important implications for the development of waste policies".

It is essential therefore to integrate as far as possible the findings for the different outlets for households waste, particularly for CA sites and collected wastes through kerbside recycling and 'dustbin' residual waste collections, in relation to the different methods of waste containment and different 'waste catchment' characteristics. This should enable variations in compositional samples to be explained more clearly, both in terms of socio-economic and infrastructure differences between areas.

The variety and thoroughness of data collection varies considerably from authority to authority, as does the compatibility of different data sources collected and the analyses performed on this data. There is no nationally agreed protocol for carrying out these studies and consequently it is often difficult to compare studies in different authorities, or to know the reliability of the compositional profile obtained. Including samples from more than one season was found by the study for the Strategy Unit to be a major factor in influencing how representative the findings were of the districts overall waste arisings, at least by weight, when correlated with annual DEFRA data. In particular it was concluded that single season studies were unreliable, and likely to be a poor guide to overall annual waste composition. The original sampled data

for the Hampshire case study application of this methodology is unfortunately a single season study and consequently was not considered sufficiently reliable to be included in the national data set used in the Strategy Unit analysis. This could cause an underlying margin of error in the overall composition analysis arrived at in the case study results, which could only be corrected by a more accurate sampled data study of waste composition being undertaken. This emphasises the Report's conclusion for the need for national agreed protocols in waste composition studies, with minimum requirements set out for data sets used for calculations of capture rates and other performance indicators. DEFRA should provide guidance on this, for without it local authorities are vulnerable to commissioning expensive but inadequate studies.

The methodology describes how sampled data can be classified by 'cluster analysis' which groups together areas with similar waste characteristics to create a generalised composition for each of the main groups or clusters obtained. In the case study this resulted in individual districts or boroughs becoming part of a group or cluster. The mean compositional profile of each cluster can be taken to be a more accurate reflection of each area's waste composition than would be produced by a simple mean of a limited set of data from that area. This approach has merit where there are only a few data points in each district or borough in reducing the overall influence of those individual data points (and in particular any erroneous data) in producing district or borough level compositional estimates. It can also be applied to other groupings of authorities or areas within authorities.

The method chosen to build an integrated compositional analysis was based on the approach of first applying the clustered group compositional analysis to the annual collected residual waste data. After similarly applying average compositional analyses to each of the annual kerbside recycling totals, HWRC and 'bring' site statistics, the four waste streams were recombined to a better indication of total household waste composition for each district

Knowing the composition of the total household waste stream has important applications in exploring strategic planning for waste management in a number of areas, including the potential for meeting the recycling targets and for infrastructure capacity. To evaluate how much material can be captured by different approaches to recycling requires not only realistic data on material diversion and participation rates achievable but also accurate knowledge of what material is potentially available in the waste stream.

The example given in the Report of the compositional profiles derived for the reconstructed waste stream, including CA site waste, for Hampshire shows a higher proportion of putrescible waste, but significantly lower percentage of paper and card, compared with the composition of collected residual waste and kerbside recyclables only. Comparing these results with national average household waste composition, also incorporating CA site waste, from the Strategy Unit report shows similar proportions of biodegradable and recyclable fractions. Applying the assumptions made in 'Waste Strategy 2000' for the proportions of different material categories that constitute biodegradable and recyclable fractions for comparability, the Hampshire data gives a biodegradable fraction of 67% and recyclable fraction of 63%. This compares to the Strategy Unit's figure of 68% for both the biodegradable and recyclable fractions.

The Report compares these results from the case study example of an integrated compositional analysis with the composition profile quoted in 'Waste Strategy 2000' based on collected waste data only. Although they produce similar recyclable fractions (60% for Waste Strategy 2000, and 63% for the Hampshire analysis) these are made up of different proportions of constituent recyclable materials. The percentage of biodegradable waste for Hampshire is 67% compared to the 62% calculated in the 'Waste Strategy 2000'. The Report concludes that compositional analysis that reflects collected 'bin' waste will give significantly different compositional profile to that based on the total integrated household waste stream.

The Report shows that the importance of accurate compositional analyses of the whole household waste stream, and not just of collected 'dustbin' waste, should not be underestimated in waste strategy development, at both a local level and also for national strategic planning. Waste strategies based on an inaccurate picture of composition can easily be skewed in different directions by what the compositional analysis suggests is or is not feasible. An important implication of this analysis is that waste strategies should no longer be based on compositional analyses that only sample collected 'dustbin' waste.

Use of Scenarios in Strategy Planning

Chapter 7 details scenarios developed in this research to explore the outcomes of policy choices on future waste and recycling performances, and how they can be used to help model specific performance targets. These scenarios explore enhanced collection provision for bring, kerbside dry recycling and kerbside green waste as a means of complying with government recycling and composting targets. This Chapter also describes a standard cost methodology approach for exploring the relative costs for different scenarios.

Scenarios are often used in strategy planning to explore and compare different options for future waste management, and some examples of these were referred to in the strategy planning review in Chapter 2. Scenarios can be used to clarify strategic options available, but only express some possible options that may exist. They should not be confused with being a choice of strategic options. Scenarios are not an end in themselves but a tool for exploring policy decisions, and unless they are designed to illuminate a specific strategic decision then they may not help policy makers identify choices.

The scenarios described in this Chapter are fairly specific in their focus and uses. These were designed to explore how specific policy changes might perform towards meeting government BVPI recycling targets. The scenarios focus around predicted capture rates that could be achieved by different developments in recycling provision. These capture rates are then applied to weight and composition data for the complete household waste stream

The Report describes and uses these scenarios to show what might be done but not necessarily how it should be done. Local authorities using scenarios in this way to assess the potential recycling performance of different waste management options available to them – based on local circumstances and local data – will need to decide how and whether the required capture rates can be met. Again judgement should be based on local experience. Material capture rate is a function of a number of factors including the level of service provision, public participation, materials targeted and the proportion of the target material captured by the scheme from participating households. Detailed on-going data collection of all these aspects and carried out in an integrated programme, and analysis of current performance, will be needed to identify where improvements can be made to achieve these high capture rates.

The first set of scenarios explored in this research considered nine scenarios, plus a baseline situation. These included increased capture through bring sites for glass and textiles, a number of options for improved capture through kerbside collection of dry recyclables, charged and free kerbside collections of garden waste, and combinations of these approaches.

The capture rates assumed in these scenarios could be based on any experience of 'best practice' for the types of schemes being considered. Most of the scenarios given as examples were those applied to the case study data and used capture rates based on current 'best' practice in Hampshire. This was assessed from analysis of sampled round data which showed the 'best' performing kerbside round to be achieving an overall capture rate of targeted materials of 63%, with a capture rate for paper and card of 75%.

The Report shows how scenarios can be used to explore which policy options might meet specific targets. Application of the scenarios to the case study highlights some trends and overall issues, and main points that emerge from the case study are:

- bring site recycling alone is unlikely to achieve longer-term national targets for recycling – 30% by 2010 or 33% by 2015;
- effective kerbside collection of dry recyclables, achieving high capture rates, can reach or come close to these targets, and combining this with either improved bring provision or kerbside collection of garden waste meets the targets more easily;
- introducing green waste collections without improved kerbside of dry recyclables is unlikely to reach these targets alone;
- the 2003 targets can mostly be met by the WCAs in Hampshire by extending & improving dry recyclables kerbside collections, with most not needing to achieve current Hampshire best practice in order to do so
- for most WCAs in Hampshire the 2005 targets cannot be met without achieving very high capture rates, mostly above current best practice, so that they may need to consider kerbside green waste collection to meet their targets.

The specific recycling and composting rates that are predicted as achievable for each scenario will obviously differ from authority to authority, since the data on existing practice, waste arisings, composition and achievable capture rates will differ between authorities.

Cost plays a critical role for local authorities in assessing different options in their waste strategy planning. However, to do so, they need comparable information on the costs and performance of different collection systems. Without this it is difficult for local authorities to implement cost-effective recycling strategies to achieve their performance targets.

The Report presents a predictive methodology that has been developed to project the costs of a range of collection systems in a standardised way. This approach for projecting refuse and kerbside collection costs enables the most cost effective systems to be identified locally, and has been used here as an illustrative example to consider the relative costs of each scenario for a collection authority in Hampshire. The costs presented in this Chapter are merely illustrative and are over simplified. More accurate modelling can be achieved with more accurate, local data, and the Report refers to other work which develops this methodology in more detail.

In building and exploring scenarios, comparative information produced by the cost modelling approach could be used by local authorities, alongside other measures of performance, to improve decision making for waste strategy planning. For instance the comparative total costs predicted for different scenarios could be cross-referenced with the predictions of the recycling rates that would be achieved using the same scenarios for that authority to influence or inform choices in the short or longer term development of strategy.

The Report cites research that concludes that 'experience suggests that most collections are currently not operating in the most cost effective way, often a high participation is considered to be more important than a high capture'. A collection that experiences a high participation but a low capture will have a much higher cost than a collection with a low participation but a high capture. Therefore, costs extrapolated from even standardised data on current recycling collections will not provide reliable estimates of future kerbside collection costs, but will need to reflect changing assumptions about potential participation and capture rates, and other influencing factors.

Source Segregation and Collection of Municipal Compostable Waste: Generating and Using Locally Derived Data

This Chapter builds on some of the source segregation and collection issues introduced in Chapter 3, by focusing on the generation and use of locally derived data relating to waste collection rates for two different but potentially complementary approaches to implementing source segregation and collection schemes. The main theme addresses decision making in relation to the introduction of appropriate collection systems for compostable green or garden waste. It addresses the use of data to predict recycling rates for different options and the effects of these on residual waste, and illustrates how the collection and use of data can improve decision making in terms of selecting best value, locally based integrated waste management options.

In an attempt to minimise the high risk involved and to introduce kerbside schemes which are tailored to local needs, many local authorities first trial different approaches, equipment and facilities in selected geographical areas. There are many examples of comprehensive and complex kerbside trials being set up where the main aim is to optimise the performance of subsequent full-scale kerbside operations. In such cases, a feature often lacking is the absence of consideration given to alternative or complementary approaches. Very often, the effects of introducing kerbside collection on bring site arisings and home composting activities are not rigorously investigated and the relationship between collection options and recycling rates is also unclear. With kerbside collections of garden waste being cited as an important reason for year-on-year increases in waste arisings, it is vitally important that source segregation systems are introduced within clear integrated waste management frameworks.

From the background material and case study data from kerbside collection trials and HWRC performance, the Report concludes and recommends that:

- a clear knowledge and understanding of existing waste characteristics and composition is fundamental to forecasting future recycling rates for different collection and waste processing options;
- developing a modelling and analysis tool to help understand waste flows and to predict recycling rates is vitally important if integrated waste management is to play an effective role in promoting sustainable waste management;
- from the case study example given in this Chapter -
 - introducing extensive kerbside collection of green waste (not including kitchen waste) could contribute significantly to meeting national recycling targets. However, care should be taken to ensure that additional waste is not created or simply diverted from other recycling routes;
 - enhancing existing facilities and/or promoting waste minimisation through home composting might be a cost-effective alternative to the introduction of free kerbside collection schemes;
 - prohibiting green waste in residual waste collections is likely to enhance HWRC use;
 - charged kerbside collections may offer an opportunity of increasing green waste collected whilst minimising green waste diversion from HWRC and home composting;
- regard should be given to building on existing recycling services and enhancing current waste minimisation activities, as well as exploring ways of combining services and introducing multiple approaches to recycling.

The Use of Modelling in Residual Waste Management Strategies

Chapter 9 addresses the physical, chemical and biological composition of each component of the municipal waste stream, and explores the effects of different source segregated recycling schemes on the composition of the residual waste remaining to be processed. It shows how potential conflicts and synergies between different elements of an integrated waste system can be investigated through modelling and scenarios.

The Report describes a methodology that can be applied to data from any waste disposal authority wishing to explore the potential and limitations of IWM based on local data. In this Chapter, data from Hampshire is again used as an illustrative case study.

Combining data on the quantity of material in each component of the MSW stream with the physical and chemical composition of each component allows different waste management scenarios to be modelled. This modelling can assess the schemes in terms of their compliance with national and local recycling and recovery targets and with the EU Landfill Directive diversion targets. Such modelling also allows the effect of recycling and composting schemes on the characteristics of the residual waste to be determined.

Data from a number of sources are combined to model the flow of materials through the waste management system for a number of the scenarios. The flows considered are in both physical terms (paper, glass, garden waste etc) and chemical terms (moisture, ash, carbon thermal content etc). These flows can then be used to characterise any of the material streams and their suitability for the different waste management options such as recycling, composting, combustion etc.

Of particular interest is the residual waste remaining after the implementation of the various recycling collection schemes. Consideration of the physical and chemical composition of the residual waste will give an indication of the suitability of the different recovery and disposal options and whether the upstream recycling scheme allows a system of IWM to be implemented. The treatment options considered in this Chapter are incineration with energy recovery; anaerobic digestion (AD) and mechanical biological treatment (MBT). AD treats biodegradable wastes by bacterial action in the absence of oxygen at high moisture contents, producing biogas and a digestate (slurry that can be dewatered to give a solid product similar to compost). MBT is a method for stabilising mixed waste in a crude composting operation that may be preceded or followed by a range of physical processes designed to extract recyclable materials or compost from the waste. In calculating the diversion rates it is assumed that the end-products of MBT can be used, which at this time is not yet clear.

The data used on the chemical composition of MSW are taken from the UK Household Waste Analysis Project (UKHAWP) (Environment Agency 1994). The UKHAWP is the only source of information on the chemical composition of MSW available, but it must be treated with caution. The Report concluded that a research programme is urgently needed to replace this decade-old data.

For the example described in the Report for the case study area of Hampshire, the modelling exercise predicted that:

- the national recovery target for 2015 of 67% cannot be met by recycling and composting scheme alone, and requires the implementation of a scheme to recover energy or materials from the residual waste;
- the proposed intensive recycling schemes do not adversely affect the properties of the residual waste in terms of its suitability for incineration, AD or MBT;
- the recycling scenarios influence the *quantity* of residual waste available for processing, but have only a minor impact on the suitability of the material for incineration, AD or MBT;

- the upstream separations for recycling and composting have no detrimental impact, and in some cases a positive impact, on the combustion-related properties of the residual waste stream.

The recovery rates calculated for Hampshire for a range of scenarios all exceed the 2015 national recovery target assuming the planned incinerator capacity of 420,000 t y⁻¹ is in operation. Similarly, the development of anaerobic digestion, or the use of MBT in conjunction with refuse derived fuel and/or compost manufacture could contribute to meeting the recovery targets.

The Report also demonstrates how the scenarios can be used to predict from the composition of residual waste the amount of biodegradable MSW diverted, and hence how effectively each scenario will be in meeting the Landfill Directive diversion targets. It concludes that whilst the recycling and composting schemes described in the scenarios will contribute to meeting the targets, some other process or combination of processes to treat residual waste will be required to achieve the 2013 and 2020 targets. The results show that incineration, MBT or AD of a proportion of the residual waste will all allow the Landfill Directive targets to be met. Although the MBT process is not as effective as incineration in diverting BMSW from landfill, it would be possible to meet the Landfill Directive diversion targets with any of the recycling scenarios combined with MBT of the residual waste. However, this assumes that a beneficial use (fuel or land remediation) will be found for the end product of the MBT process. AD is less effective than incineration and MBT in treating the residual waste, due to the fact that over half the residual waste is unsuitable for digestion, but will only allow the Landfill Directive targets to be met when used in combination higher diversion for recyclable and compostable materials.

In Summary

This Report offers and illustrates a number of tools to assist local decision making, and in developing waste strategies. Part One identifies the deficiencies in data use in current waste strategy planning, as well as highlighting the important aspects of collection systems to be considered when developing plans. Lack of good data on many aspects of performance restricts what can be achieved in planning better integrated, more sustainable waste management provision. Part Two identifies ways of addressing these deficiencies through more effective data collection and analysis.

The Report is intended as a guide illustrating improvements that could be achieved in planning integrated waste strategies using better data and analyses to inform decision making. It is not intended to be prescriptive, but designed so that Chapters are stand-alone examples that can be dipped into as and when required.

Chapter 1 — Introduction

Waste management in the UK is currently going through a period of considerable and rapid change, with the resultant accompanying and inevitable activity in strategic planning. Much of this change is being driven by UK government initiatives. These are focused around the 'Waste Strategy for England and Wales 2000' and more recently the Cabinet Office's Strategy Unit report 'Waste not, Want not: A strategy for tackling the waste problem in England', the 'National Waste Plan' for Scotland, and 'Wise about Waste: The National Strategy for Wales'. In addition a strong factor in shaping strategic planning in England is meeting the Best Value Performance Indicator (BVPI) recycling and recovery rate targets set by DEFRA (Department for Environment, Food and Rural Affairs) for individual local authorities. EU Framework Legislation and Directives are also significant drivers in waste management today; and meeting the requirements for diversion of biodegradable wastes from landfill of the Landfill of Waste Directive (EU Council Directive 99/31) in particular will effect changes in our waste management practices.

Alongside these drivers for change, local authority waste management strategic planning will be shaped by numerous other factors, including existing infrastructure and waste management systems, financial constraints, political climate and influences – particularly locally but also nationally and internationally, social issues, knowledge, contacts and prejudices will all play a part. Balancing these often-conflicting demands, and planning in an integrated way for sustainable waste management, is one of the challenges faced by local authorities today.

This Report is aimed at helping authorities face this challenge by showing how recognising and responding to strategy information needs combined with the role of locally-based data can promote waste strategy planning based on local conditions and which is truly relevant to local needs. The Report is intended as a guide illustrating improvements that could be achieved in planning integrated waste strategies using better data and analyses to inform decision making, it is not, however, intended to be formulaic. It has been designed so that each Chapter can either be read consecutively, independently or 'dipped into' as required.

This introductory Chapter sets the context by briefly discussing the concepts of Integrated Waste Management and Best Practicable Environmental Option, and then outlines the major influences on, and information needs of, waste strategy planning. Whilst a small number of these influences have been well developed elsewhere, and therefore are not discussed in detail here, the majority have not been addressed methodically in relation to local information and hence relevant local strategies. This Report addresses this deficiency, and shows that strategic planning for integrated waste management could be radically improved with the use of better and locally relevant data, information and analyses. The Chapter concludes with the structure of this Report and details the information needs and influences that form the basis of subsequent Chapters.

1.1 What is Integrated Waste Management?

It is clear that there is no one single method that can deal with all waste materials in an environmentally sustainable way. Rather than focusing and comparing different waste options, Integrated Waste Management (IWM) is concerned with synthesising a range of different options to deliver an environmentally and economically sustainable system for a particular area (White *et al*, 1995). Hence, it describes an approach in which decisions on waste management takes account of different waste streams, collection, treatment and disposal methods, environmental benefits, economic optimisation and social acceptability. Although a relatively straightforward concept, planning and delivering a system that integrates collection and treatment methods to achieve a balance that strives for environmental sustainability and cost

effectiveness is complex and dynamic. It is not simply a linear process of adding together different methods – authorities need to look at how source segregation collection options affect treatment options and vice versa; and find a balance that optimises performance whilst achieving their aims and goals.

Box 1.1 – Definitions of Integrated Waste Management

Waste Not Want Not - Strategy Unit (2002)

Wise About Waste - National Assembly for Wales (2002)

Integrated waste management involves a number of key elements, including recognising each step in the waste management process as part of a whole, involving all key players in the decision making process and utilising a mixture of waste management options within a locally determined sustainable waste management system

National Waste Strategy for Scotland - SEPA (1999)

Integrated waste management refers to “the development and delivery of waste management systems and services which, with a high degree of planned efficiency and at an acceptable balance of costs and benefit, are capable of minimising the level and hazard of waste produced, and maximising resource use efficiency and value recovery from wastes that are produced, whilst protecting the environment and human health”

Planning and delivering IWM is a key objective of national and local waste strategies; Box 1.1 outlines IWM definitions from the Office of the Deputy Prime Minister’s Strategy Unit, National Assembly for Wales and SEPA waste strategies. Chapter 2 of this Report reviews waste management authorities planning documents and strategy plans, and shows that whilst the term *integrated* is used repeatedly by all authorities, it was not necessarily reflected in an integrated approach, either to the planning process, or the systems proposed to provide the future basis for waste management in their area. Most mention consideration in their choice of waste management of a number of factors including not only cost, but ability to meet Best Value targets, to satisfy political or social considerations, the overall environmental impacts, and seeking the Best Practicable Environmental Option (BPEO). However it is rare to find an authority which considers all these aspects and even rarer one who attempts to integrate these multiple criteria in its decision making process.

The majority of strategy plans considered, even those that mentioned or discussed the need to identify and choose the BPEO based their priorities on the ‘Waste Hierarchy’. This generally leads to a linear approach in setting priorities, even though the focus of attention rarely actually reflects the priorities of the Hierarchy. Many strategies begin by discussing tackling waste avoidance or minimisation, and then consider what source segregation plus recycling and composting can achieve. If these measures are not considered adequate to meet the authorities obligations for diversion from landfill then plans for Energy from Waste (EfW) processing or alternative biological treatments, as the next preferred option, may also be discussed, in addition to provision for landfill. The simplicity of approach this offers, and the fact that priorities can be set without the need for extensive information concerning the waste stream being dealt with, and the fairly universal acceptance of the ‘Hierarchy’ as offering the preferred environmental solutions, explains its popularity. However it has considerable drawbacks as an approach to *integrated* waste management; it is not possible with the ‘Hierarchy’ to consider different combinations of processes or scenarios for optimising the treatment of the whole waste stream.

Neither does it consider any interaction between the demands and requirements of each option, making no allowance for feedback loops in the overall assessment of these options for waste management. As McDougall and White (2000) reflect, how can the Hierarchy be used to decide whether a waste management system, using a combination of composting and EfW, is better or worse than one with a combination of recycling and landfill?

1.2 Assessment of Best Practicable Environmental Option (BPEO)

Identifying the waste management system that is the BPEO for a specific area offers a more integrated approach. It provides an overarching concept that if carried out thoroughly allows the policy makers a methodology for evaluating a variety of criteria in determining the 'best' option for IWM. Using locally based BPEO decisions for integrated waste management planning is central to national waste strategies, and the BPEO concept is based on the definition of the Royal Commission, given in Box 1.2.

Applying a BPEO procedure to help identify a 'best' option for waste management requires a set of criteria against which 'best' is evaluated. It might be, for example:

- Least polluting emissions
- Least contribution to CO₂ and methane emissions i.e. global warming potential
- Least cost
- Least risk
- Greatest public acceptance
- Least health risk to workers
- Meeting government and EU targets

Box 1.2 – Definition of Best Practicable Environmental Option

Royal Commission on Environmental Pollution (1988)

The outcome of a systematic consultative and decision making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefits or least damage to the environment as a whole, at acceptable cost, in the long term as well as the short term.

Although national waste strategies place BPEO at the heart of waste management decision making, the Government recognises that it is not as widely used or as fully adopted, as it would like to see. The Office of the Deputy Prime Minister's 'Guidance on Option Development and Appraisal for Strategic Planning for Sustainable Waste Management' sets out a methodology for appraising strategic waste management options to enable BPEO assessment. It takes account of environmental, socio-economic and implementation issues, and is aimed at providing a methodology that is more comprehensive and transparent in decision making than methodologies used to date (ODPM, 2002).

Authorities that have adopted the BPEO approach have mainly used a combination of assessing environmental impacts of different options through LCA (Life Cycle Assessment) or LCI (Life Cycle Inventory) and cost in their evaluation. Whilst this approach has the potential for a thorough assessment of environmental impacts, it may be of limited value in practice as the

BPEO can only be reliably identified if valid and comprehensive information, and particularly locally accurate data, is available to carry out the LCI analysis. According to the ODPM's guidance, most BPEO assessments for waste management have focused on environmental emissions and resource depletion, but have generally failed to account for local conditions and socio-economic issues, and approaches are often inconsistent.

In addressing these limitations in BPEO assessment, Government guidance recommends incorporating LCA with other key elements such as reviews of the current situation, research and analysis for contextual evidence, meetings/workshops to agree objectives, appraise options, define weights and undertake sensitivity analysis, and using independent facilitators. As data in LCA models tends to be generalised rather than site or area specific, the Government recommends that LCA tools such as WISARD 'should be used as a high level and broad comparison of relative advantages and disadvantages – not as indication of real, local impacts' (ODPM, 2002). WISARD is a life-cycle analysis tool for waste management planning developed by the Environment Agency and SEPA. The limitations of LCA tools such as WISARD have been discussed extensively elsewhere but in most part focus on the validity of inbuilt model assumptions and accuracy of data. In essence the outputs can only be as good as the data and assumptions fed in. In its consideration of data assessment for carrying out BPEO appraisal, the guidance focuses on the amount and type of waste at a sub-regional level, on infrastructure and transport, and on contextual information for understanding indicators and helping establish weightings.

In developing their waste strategy for Scotland, SEPA used a transparent BPEO procedure that incorporated LCA together with many of the elements subsequently recommended in the ODPM guidance. This approach identified several initial waste management options based on specific local data gathering, and a series of evaluations through workshops involving wider stakeholder groups. Options were evaluated against a list of national and local decision criteria, and potential impacts assessed qualitatively and quantitatively. The result is waste management solutions that achieve the best balance between environmental, social and economic costs and benefits, which are specific to local areas and approved by local stakeholders (SEPA, 2003). Although not widely adopted at present, such an approach will be increasingly used by local authorities as a way of balancing elements in IWM.

1.3 Strategic Planning for Integrated Waste Management

As mentioned earlier, in addition to cost and environmental impacts, the existing infrastructure, political factors, social issues, and legislative framework, all influence strategy planning. Decision-making needs to be able to balance all these criteria. To make informed decisions strategy planners need to be able to evaluate options against all these criteria, and to do this they need to understand and meet local information, data and analysis needs, as well as assess how realistic the relative options are in meeting their objectives. Figure 1.1 illustrates the major influences on, and information needs of, strategy planning.

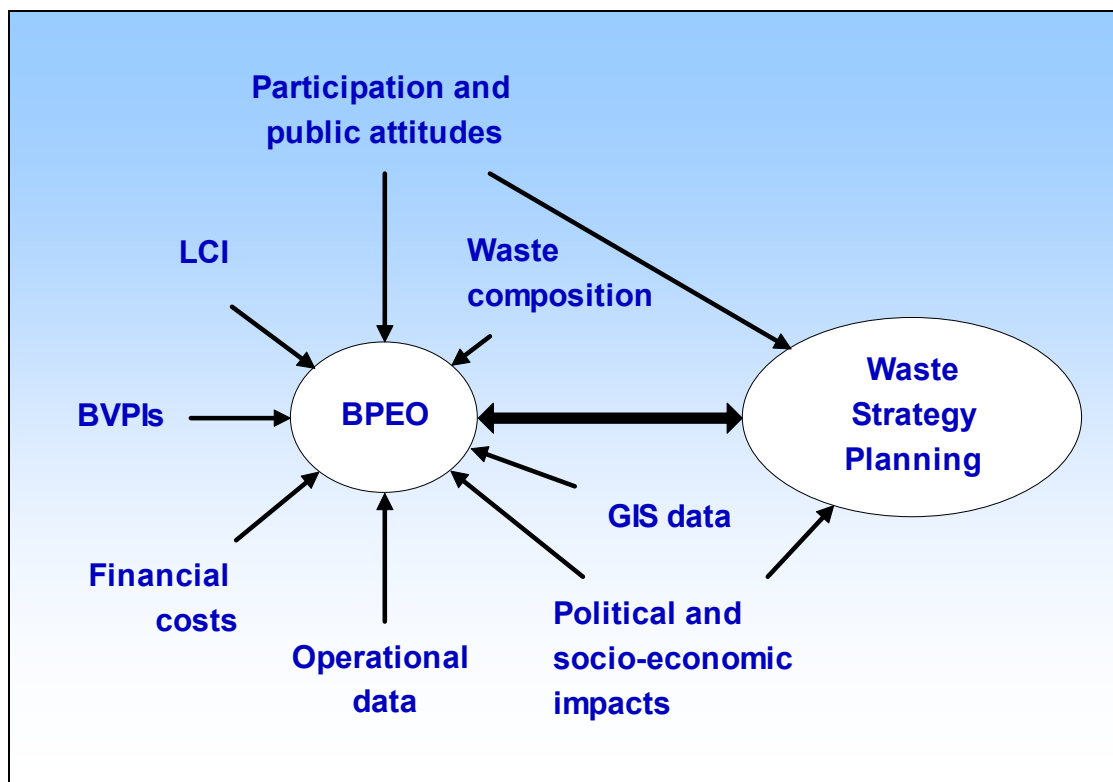


Figure 1.1 – Information needs of waste strategy planning

Much of what is written on waste management strategy planning focuses on the tools available to local authorities and others in evaluating different options, such as computer models for assessing different options, cost minimisation or optimisation techniques, models for evaluating LCI or models which consider both these parameters. There is a growing body of analysis and literature evaluating the role of LCI, EIA and BPEO in waste management, describing a variety of different approaches, methods and models. More recently models assessing options for integrated waste management planning are likely to include both costs and emissions, with many incorporating LCA of environmental impacts. Examples of integrated waste management modelling are described in Barlিশen and Baetz (1997); Sundberg and Ljunggren (1997); Powell (2000); Powell *et al* (1998); Bjorklund *et al* (1999); Mirza (2000); McDougall and White (2000) and Tanskanen (2000). Most commentators on IWM modelling fail to provide sufficient focus on the quality of information needed to make these models work to give realistic and sensible outputs.

Alongside the development of these tools to assess different waste options, an increasing variety of indicators have been introduced to evaluate local authority performance, for example performance indicators for kerbside recycling schemes for household waste. Separately these will tell us how well a scheme is performing in particular ways but not why or how to go about improving performance. To achieve this, schemes need to be evaluated using a variety of approaches and the interplay between these measures examined.

Good information is essential to underpin waste strategy planning. Much past and current strategy planning in waste management is not based on thorough analysis. The need is great for good, reliable detailed local information and data on waste arisings, obtained using rigorous and uniformly applied protocols, for local authorities to be able to plan realistically to meet specific targets. In addition, good information on costs, environmental impacts, social and political impacts of different policy options are crucial for local authorities to be able to plan for sustainable and integrated waste management. 'More then ever before, solid waste management policy-makers world-wide need sound and reliable information on the technical

performance, environmental impact and costs of solid waste collection, recycling, treatment and disposal' concluded Read (1999).

This poses the question as to what types of data are appropriate and needed most by local authorities to enable them to plan strategically. We need to identify what new information is needed specifically to deal with integrating a range of waste management options, and allow realistic scenario building to support local authorities in their decision-making. Before decisions can be made, those making policy need to:

- know what the environmental impacts are of different options;
- understand weight and composition of the total waste stream being dealt with;
- be able to predict future arisings;
- know where wastes come from and how to optimise collection and treatment infrastructure;
- understand public attitudes and political factors involved;
- calculate cost implications; and
- consider contractual arrangements and constraints.

1.4 Information Needs and Locally Based Data for IWM Strategy Planning – Structure of the Report

This Report reviews how data is currently used in waste strategy planning and explores the role that could be played by a number of specific data types. It identifies areas where improved data and information use could radically improve strategic planning for IWM, and offers examples of case studies to illustrate this. The approach developed focuses on the types of information and analysis that could or should be included in the assessment of future options to determine strategies for IWM; including scenario building, geographical information systems, compositional analysis and residual waste composition, combined with the importance of relevant local data and how it might be gathered, so that local data provides local answers. Figure 1.2 illustrates the components of this Report, and shows how the interplay of these components could inform strategies for IWM.

An important element in Figure 1.2 and an underlying theme throughout this Report is the importance of source segregation for IWM planning, because:

- source segregation is increasingly important in moving towards re-use, recycling and composting targets;
- there is a need to integrate source segregation schemes within the overall waste management strategy;
- participation is key to source segregation;
- it is important to consider 'what if' scenarios based on different contribution from bring, kerbside, and different participation and capture rates, and the impact that these have on the residual waste stream.

Part Two identifies ways of addressing these deficiencies through more effective data collection and analysis. It suggests a variety of tools that can be used to inform decision making in waste management. These include scenario building, the use of trials to collect relevant data, geographical information systems, compositional analysis and residual waste composition. The Report describes examples of using these tools to illustrate and inform discussion, rather than as a manual for prescriptively applying them.

The outline of the Report is summarised as follows:

Part One

- | | |
|-----------|---|
| Chapter 2 | A review of the use of information in building local authority waste strategy plans in the UK |
| Chapter 3 | A review of source segregation, bring and kerbside collections |

Part Two

- | | |
|-----------|--|
| Chapter 4 | Geographical information systems (GIS) and their potential application for waste strategy planning.

This Chapter reviews the current use of GIS in public service delivery, and gives examples of the potential usefulness and application of GIS techniques for developing waste strategy plans, and in enhancing waste service provision and delivery. |
| Chapter 5 | The role of understanding public participation in developing waste strategy.

Public participation is a key factor for successful source segregation. This Chapter examines the effect of public participation and understanding on capture rates and overall recycling performance. It demonstrates the importance of data on participation and the calculation of locally relevant capture rates, and of understanding targeting to improve these. The effect on recycling performance of different participation rates is a vitally important factor, and underpins the different scenarios detailed in the Chapter 7. |
| Chapter 6 | Compositional data to improve waste strategy planning.

This Chapter focuses on the importance of good composition data. It offers a methodological approach to collecting and analysing composition data that allows data collected from different household waste streams to be integrated to give a profile of the total municipal waste stream. Data integrated in this way will give a more accurate basis for evaluation of performance and planning to achieve recycling and other targets. |
| Chapter 7 | Use of scenarios in waste strategy planning.

This Chapter looks at building scenarios that can be used to explore the outcomes of policy choices on future waste and recycling performances, and how they can be used to help model specific performance targets. These scenarios are developed in the context of a case study that explores enhanced collection provision for bring, kerbside dry recycling and kerbside green waste as a means of complying with Government recycling and composting targets. This Chapter also considers a standard cost methodology for exploring the relative costs for the different scenarios. |

Chapter 8 **Source segregation and collection of municipal compostable waste: generating and using locally derived data.**

This Chapter builds on some of the source segregation and collection issues introduced in Chapter 3, by focusing on the generation and use of locally derived data relating to waste collection rates for two different but potentially complementary approaches to implementing source segregation and collection schemes. It addresses the use of data to predict recycling rates for different options and the effects of these on residual waste, and illustrates how the collection and use of data can improve decision making in terms of selecting best value, locally based integrated waste management options.

Chapter 9 **The use of modelling residual waste in strategy planning.**

This Chapter addresses the physical, chemical and biological composition of each component of the municipal waste stream, and explores the effects of different source segregated recycling schemes on the composition of the residual waste remaining to be processed. It shows how potential conflicts and synergies between different elements of an integrated waste system can be investigated through modelling and scenarios.

Part 1

A Review of Waste Strategy Planning and Source Segregation

Chapter 2 — Building Local Authority Waste Strategy Plans

The UK Government, Scottish Parliament and National Assembly in Wales have published a number of documents related to developing both national and local waste strategies for the future management of municipal wastes. This Chapter is concerned with issues around the kinds of advice being provided by national government agencies, and whether and how these might be being taken up at a local level. It takes a brief look at some of the current guidance being offered to local authorities in England, Wales and Scotland.

2.1 Government Guidance on Preparing Waste Strategies

2.1.1 *DEFRA guidance on 'Municipal Waste Management Strategies' for English Local Authorities*

This guidance was published in 2001, and follows on from the publication of the 'Waste Strategy 2000' and 'Waste Strategy Guidance – Best Value and Waste Management'. Municipal Waste Management (MWM) Strategies are not statutory at the moment, but it is the government's intention to make them so. MWM Strategies are expected to set out a strategic framework for the management of municipal waste, jointly developed and subscribed to by the waste collection authorities and waste disposal authority (or authorities if smaller authorities in an area wish to prepare joint strategies). They 'will need to demonstrate how the authorities will meet the objectives and targets in the Waste Strategy 2000'

The main aspects that MWM Strategies need to cover are:

- the authorities' objectives and standards for the service;
- inclusion of policies and plans on how to achieve these objectives and standards;
- provision of a framework for monitoring and evaluating progress;
- communication of these plans to Government, key stakeholders, partners and the wider community;
- addressing how the authority works in partnership with others concerned with waste management;
- incorporating the statutory Recycling Plans prepared by Waste Collection Authorities (WCA) in the area;
- waste planning authorities should also assess the BPEO for the different waste streams that will need to be managed in their areas;
- waste planning authorities should allocate sites for any new or extended waste management facilities required in their waste development plans. Authorities should ensure that these plans are prepared in accordance with the National Waste Strategy and PPG10 'Planning and Waste Management' (DETR, 1999).

The 'Guidance' is fairly clear and detailed in suggesting what types of information should be contained in the MWM Strategies, much of which relates to policy and planning decisions and proposals. The 'Guidance' specifically refers to the inclusion of and use of data throughout and specifically that the following statistics and data could be usefully included:

- headline targets and statutory performance targets;
- waste Performance Indicators as required under Best Value;
- key information provided to DEFRA as part of the annual Municipal Waste Survey;
- number and location of civic amenity/recycling sites;

- treatment and disposal capacity, on a site by site basis;
- basic background data: population, number of households, area;
- waste volumes and composition, particularly local arisings;
- maps of area and waste facilities.

The data requirements of the Recycling Plans that should be including in the strategy documents are more specific, and include the kinds and quantities of controlled waste which the authority expects to collect or purchase, or to deal with for the purposes of recycling.

The general tone of the 'Guidance' is that the MWM Strategy should demonstrate that the authority intends to meet their targets and how – but not necessarily the need to show the basis for how these proposals were arrived at. It mentions the need to identify and analyse the available options, but doesn't say that the authorities have to use and analyse data to support their proposals. It also states that the MWM Strategy should 'bring existing waste data for the participant authorities together' and present this information in a clear format; and that it should 'quote the source and date of any data, and distinguish between actuals and estimates'. As an example it refers to the Cambridgeshire and Peterborough joint strategy, where the authorities involved have established a data sub-group.

2.1.2 The ODPM's guidance on option development and appraisal for strategic planning for sustainable waste management

This guidance, issued in 2002, seeks to address the limitations of BPEO assessment. Although, as it states 'Waste Strategy 2000 puts the concept of BPEO at the heart of waste management decision-making', there is recognition that it not as widely or as fully adopted as government would like to see. The guidance sets out a methodology for appraising strategic waste planning options that takes account of environmental, socio-economic and implementation issues, and is aimed at providing a methodology that is more transparent in decision-making. Primarily it addresses issues at a regional level, and from a waste planning perspective.

The appraisal methodology described includes 7 steps:

- identifying and agreeing objectives and indicators for appraising options – by elected members at a regional level where possible;
- developing strategic waste planning options– options need to meet key objectives;
- data collection, including number and types of waste management facilities required, characteristics of facilities, transport etc.;
- appraising options – using quantitative methods such as WISARD for resource use and emissions; generic data e.g. for land requirements; expert judgement e.g. visual impact – assess performance of options in actual data, or calculated performance scores; describes performance matrix; how to go about ranking and 'valuing' performance to simplify matrix;
- weighting indicators: because 'decision makers are likely to attach more importance to some indicators or criteria than others' weighting allows this relative importance to be taken into account; may include other stakeholders in this aspect;
- identifying a preferred option: using all above – can now see which option meets objectives best;
- sensitivity testing and option refinement: determine which are most significant indicators in terms of their impact on the robustness of the decision and make sure these are looked at in as much accuracy as possible.

This guidance report is not as prescriptive in how to carry out these steps as the SEPA guidance described below. It suggests some key elements to be covered such as reviewing the current situation, research and analysis for contextual evidence, meetings/workshops to agree objectives, appraise options, define weights and undertake sensitivity analysis, and using independent facilitators. It also recommends use of WISARD (or an equivalent LCA tool), but comments on some potential problems with its use. It suggests that LCA 'should be used as a high level and broad comparison of relative advantages and disadvantages – not as indication of real, local impacts', as the data in the models is generalised, not site or area specific. The limitations of LCA tools such as WISARD have been discussed extensively elsewhere but in most part focus on the validity of inbuilt model assumptions and accuracy of data. In essence the outputs can only be as good as the data and assumptions fed in. In its consideration of data assessment for carrying out this appraisal, it focuses on the amount and type of waste from WDAs and WCAs, on infrastructure and transport, and on contextual information for understanding indicators and helping establish weightings. There is little guidance on assessing local factors such as potential recycling performance, or assessing how realistic the options being compared are in meeting their objectives.

It provides a case study of an assessment of options for the North West RTAB, and quotes performance tables, performance matrix, ranking and weightings used. It also suggests methods for carrying out weightings.

2.1.3 Waste strategy in Wales and guidance on municipal waste management strategies from the Welsh Assembly Government

Although the Waste Strategy 2000 applied to England and Wales, development of advice and detailed implementation of the strategy aims have been taken forward for Wales by the Welsh Assembly. As part of this process the Assembly published in July 2000 a waste strategy consultation document 'Managing Waste Sustainably'. This was followed in 2002 by 'Wise About Waste: The National Strategy for Wales'. The strategy states 'waste is the most important environmental problem facing us in Wales today'.

This strategy emphasises sustainability and seeks to improve resource productivity and the environmental impact of resource use in Wales. It is a waste elimination led strategy, with recycling the preferred way to manage unavoidable waste. To achieve its aims the report cites the need for research, developing and disseminating good practice through exemplar Local Authorities, a permit system for landfill, and increasing awareness. Guidance for developing municipal waste strategies was issued shortly after the National Strategy, and covers what should be in MWM strategies, how to assess BPEO, consultation issues, and covers Recycling Plans. The strategy states that Local Authorities should determine BPEO, and the guidance expands on this by referring to other guidance and relevant techniques. These include the multi-criteria analysis approach to ensure that trade-offs between criteria are transparent, iterative, flexible and comprehensive; the BPEO report from SEPA; and WISARD. The guidance however gives very scant detail overall and in relation to the assessment of options. It refers to the need for a compositional analysis protocol but doesn't define one.

The Welsh Strategy and accompanying Guidance was issued later than those in England and Scotland, and for this reason this Report doesn't include examples of Local Authority strategy plans in Wales, but focuses on strategy planning in authorities in England and Scotland.

2.1.4 National waste strategy in Scotland and SEPA guidance

The approach taken in Scotland differs from England and Wales in a number of ways. The Scottish National Waste Strategy was published in 1999 by SEPA (Scottish Environmental Protection Agency), and set out proposals for how Scotland should move towards a more sustainable approach to managing waste and meet the requirements of the Landfill Directive. An underlying principle of the approach taken by SEPA is the importance of local planning and ensuring that decisions about how to meet the strategy are taken locally.

SEPA has taken strong role in working with local authorities in Scotland in developing waste management strategies, and the NWS set a process in motion which involved setting up 11 Waste Strategy Areas (WSAs) and for each a Strategy Area Group (SAG) to develop regional strategies with support from SEPA. Each SAG consists of local authorities, and other key stakeholders usually including representatives from the WM industry, community groups and local enterprises. Each SAG was set the task of preparing a draft Area Waste Plan (AWP), in consultation with local stakeholders. Integration of these AWP's informed the development of a revised National Waste Strategy Scotland published in 2003. This strategy sets out Scottish targets and addresses the question of AWP's delivering these targets.

SEPA has issued detailed guidance and a robust process for SAGs for preparing their AWP's, including preparation of a Strategic Waste Management Baseline Assessment (SWMBA) with details of what data should be gathered and included, as well as a thorough process for identifying the BPEO for each area.

The approach taken to identifying the BPEO involves a series of evaluations and data gathering carried out by the SAG and through workshops involving wider stakeholder groups. It is designed to identify initially 5-6 integrated WM options, and to evaluate these against a list of 20 national decision criteria as well as any additional specific local criteria identified, each with a series of questions to consider regarding what type of impact the option might have. Impacts can be assessed in a variety of ways including qualitatively using expert opinion or in some cases quantitatively by assessing financial costs for example, or by using WISARD to evaluate environmental impacts. SEPA strongly emphasise the use of WISARD by SAGs. The results of this evaluation are then compared using a decision matrix and options grading table to judge the best options for short-listing and examining using a similar process but involving more detailed and focused comparisons. The final result should identify a clear BPEO for the area, that can be taken forward into a more detailed strategy plan for future WM. SEPA also provide data and consultancy support for the SAGs in producing both the SWMBA and AWP's.

2.2 Status of Strategy Planning

This review of strategy planning in the UK in 2002 is not a survey but an indication of the current state of play. Although a survey carried out by NAWDO (National Association of Waste Disposal Officers) in 2001, only reported two authorities with finalised MWM Strategies, many more are available as drafts for consultation, with quite a few published on the authority's web-site, as well as the strategic aspects of Recycling Plans and Waste Local Plans. This section reviews a selection of plans across England, and comments on some plans in Scotland and some international examples of strategy planning.

Table 2.1 Authorities whose plans have been examined include:

English Authorities:	Scottish Authorities:
Medway	Argyll and Bute
Surrey	Forth
Milton Keynes	Fife
Hampshire / Project Integra	
Essex	
Cambridgeshire and Peterborough	International examples:
Bristol	Barcelona, Spain
Cornwall	Dublin, Ireland
Gloucestershire	Donegal, Ireland
Greater London Authority	London, Ontario, Canada
Hounslow	Nova Scotia, Canada
Lambeth	Edmonton, Canada
Staffordshire and Stoke-on-Trent	Canberra, Australia
Birmingham	California, USA
Hereford and Worcester	
Cleveland	
Durham (including Sunderland and Darlington)	
Doncaster	
Manchester	
Cheshire	

Types and range of strategies considered:

- England: looked at reports and documentation from 11 CCs (County Councils), 6 UAs (Unitary Authorities) and 3 Metropolitan councils; with a spread across the country as a whole including 2 from NW region, 2 from NE, 1 from Yorkshire and Humber, 3 from West Midlands, 2 London Boroughs and the Greater London Authority (GLA), 5 from SE, 2 from E and 3 from SW;
- Scotland: 3 of the 11 regional SAGs (Strategy Area Groups) are looked at; two of which had produced draft Area Waste Plans (the equivalent strategy plan for Scotland) and one a consultation document – Waste Issues Plan – prior to completing their AWP;
- most reports are prepared by the local authorities themselves, although many used consultants for all or specific aspects of their strategy development, or for studies and supporting documentation used in preparing the reports; such as Cornwall who commissioned a number of studies including an assessment of BPEO, the use of rail transport, civic amenity (CA) site provision, and a strategic environmental appraisal of their draft plan; a few employed consultants to provide full strategy plan consultations;
- of 20 areas considered in England, 14 had published (some draft or consultation) Strategy Plans, and the rest included strategic planning sections in Waste Local Plans or Recycling Plans. Most published their documents on their web-sites. Some had been produced in response to DEFRA Guidance but many pre-dated its publication in March 2001 – but most

LAs who had earlier strategies referred to these being revised and updated at present time; range of document dates from 1997 to 2002, with the majority produced in 2000/01;

- NAWDO surveyed its members in 2001 on their progress towards preparing Joint Waste Management Strategies, and had 29 responses – 21 from CC's, 7 UAs and 1 Joint Waste Authority (a 36% response from the 80 authorities contacted); of these the majority (26) had Strategies underway. 15 had published consultation drafts, with only 2 completed, although 5 authorities considered their consultation draft to be a final document. Only one had not yet started. However it is not clear whether the sample that responded might be biased towards those involved in strategy planning, with those not yet started being more reluctant to respond. The majority of authorities included some consultation, and made their proposals known to stakeholders. 12 put their documents on their web-site, 10 published drafts or consulting documents and 7 produced summaries; however 11 had published no documents at all.

2.3 Data Included in Strategy Plans

The range of strategy documents were reviewed in terms of what data is actually included and how it is used.

2.3.1 *Waste arisings and waste management infrastructure information*

This section covers information on waste weight data, including total household waste; total municipal waste; residual waste; kerbside recycling; bring and CA site data; and waste growth. Also it includes information on the waste management infrastructure, including details of CA and bring site provision; numbers or percentages of households served by kerbside schemes; types of recycling facilities/collections provided; and waste treatment facilities.

- All strategies, WLPs and Recycling Plans include information about how much waste is dealt with by the authority; most include totals for both household and municipal waste data.
- Only 12 of the areas reviewed in England (just over half) include detailed data on wastes dealt with by different collection methods including residual waste collections, kerbside recycling, bring systems and CA site wastes; some also include wastes dealt with by voluntary groups as well as those collected by the local authority.
- Some CCs only include overall data for their area, but most give some breakdown by district or WCA areas included in the WDA.
- A few authorities gave very inadequate data – such as Gloucestershire where the data presented in their WLP was very vague, providing only volume estimates for waste to landfill without tonnage figures and dividing waste into special, inert and degradable categories rather than household and municipal. However the most common inadequacy here relates to authorities only providing figures for the total amounts of waste handled without any further detail.
- Nearly all plans discussed waste growth and gave predicted figures for growth rates and total arisings for years up to 2010 and further; not all explained on what criteria these predictions were made; some just based these on past growth rates, whereas others considered predictions of population growth and household size trends; Essex's strategy focused on the effects of different waste minimisation policies on waste growth and modelled this; only 3 areas did not consider waste growth.
- Most strategy documents give information on the waste management infrastructure provided by the local authority; types of facilities, numbers and in some cases locations (4 included maps), especially for CA sites and bring facilities; most mention landfill provision

and EfW plant(s) and compost sites where these are part of waste management system; at least 5 strategy documents contained inadequate information about what facilities were provided or planned for managing waste in the authority; very few discussed the percentage of households covered by recycling facilities – such as percentages of households offered kerbside collections or number of households per bring facility.

2.3.2 Waste composition data

This section looks at data on waste composition, including analyses of sampled collected waste; CA site surveys; operational data on collected wastes, bring and CA sites where this is classified by materials; and integrated data for collected, bring and CA sites.

- Locally generated data on composition of household wastes is frequently not available.
- Only 10 of the reports considered referred to local studies of waste composition involving sampled surveys of collected household waste; of these only 2 referred to analyses of CA site wastes; Cheshire's strategy referred to composition analysis sampled over four seasons and analysed by calorific value, biodegradability and recyclable fractions, as well as the usual material categories – this report also considered waste arisings and composition by socio-economic group.
- 4 others used data from either national studies or from similar authorities which had carried out surveys – e.g. Lambeth used Southwark data, and Cambridgeshire and Peterborough used data from Hampshire.
- 6 authorities made no mention of composition of household waste in their strategy documents.
- 5 authorities included some operational data by different waste material categories – especially in relation to amounts of recycled materials collected through kerbside schemes, bring and CA sites, as these quantities are usually recorded by material type.

2.3.3 Participation rates and public attitude surveys

This section considers participation and public attitude information, including set-out rates; participation rates; levels of understanding; capture rates for different recyclables; MRF reject rates; and public attitude surveys.

- This is the performance indicator that is least considered in these strategy documents, with only 4 authorities quoting any data based on local studies of participation by the public in recycling activities.
- Of those authorities that look at participation, only two discussed variations between different areas and possible socio-demographic influences.
- More coverage is given to public attitude surveys, generally undertaken as part of the consultation process in building the strategy. Some asked for self-reported participation information, but most focus on attitudes towards waste issues and policy options.
- 11 authorities refer to public consultations and/or attitude surveys.
- Only 4 authorities give some data on capture rates for recycling.

2.3.4 Performance indicators including BVPIs

This section looks at the inclusion and use of some of the main BVPIs and other performance indicators in planning to meet the targets, such as recycling, recovery, diversion, capture, participation and set-out rates.

- The authorities surveyed covered a range of recycling or recovery rate performance from currently recycling very little to those amongst the best performing authorities in the UK.

- At the better performing end of the scale: Hampshire CC had BVPI recycling rate of 23% in 99/00; Essex achieved 18%; Peterborough UA 18%; Hounslow London Borough 17%; and Milton Keynes UA 16.5%.
- Those recycling the least included: Greater Manchester Disposal Authority 3% BVPI recycling rate in 99/00; Middlesbrough UA 3%; Gloucester CC 3%; Durham CC 4%; Hereford CC 4%; and Cornwall CC 4%.
- Those strategy documents which were prepared after publication of BVPIs all included reference to these indicators and local rates achieved; likewise those planning after the government set recycling targets for individual authorities refer to these in their strategies.
- Most quote recycling rate but few include other indicators such as recovery rate – although those with EfW elements in their waste management systems are more likely to quote this – or diversion rates, capture rates for specific recyclables, participation or set-out rates.
- There are wide variations in how these indicators are used in the strategy documents; 12 authorities though do little more than mention relevant rates or targets, and refer to meeting them; only 4 authorities examine what these rates and targets mean in terms of tonnages of materials required to be diverted from landfill and how their strategy proposals will meet them.

2.3.5 *Environmental impact data and assessment of BPEO*

Most Strategy Plans, Waste Local Plans and Recycling Plans refer to achieving the BPEO as an *overall aim* or objective of the authority, but few take the concept much further than this; they are more likely to relate their choices to the Waste Hierarchy as it is simpler to justify.

- 13 English authorities do not include any *data* on comparative environmental impact of different policy options or assess the BPEO.
- 7 English authorities mention the use of LCI, using WISARD or the Procter and Gamble model, all of which were carried out by consultants; but only Bristol, Cornwall and Cheshire include a summary of the LCI results in their strategy documents and take this further to make an assessment of the BPEO based on this; others refer to overall conclusions or just suggest that their proposed plan is the BPEO without justification.
- Only one authority, Cheshire, describes making an assessment of BPEO that follows government guidance in assessing options against a variety of criteria, not just LCI assessments of environmental impact and cost, and includes identifying weightings to allow overall judgement of BPEO; Essex report a similar assessment (although they do not refer to it as finding the BPEO) of ranking 6 scenarios against environmental, cost and other factors to use in their public consultation to find out which options are preferred by the public.
- Some authorities, including Surrey, Milton Keynes and Staffordshire, leave establishing BPEO or measuring environmental impact to waste management companies tendering for contracts or to specific planning permission applications.
- The situation in Scotland is different in that the guidance given to Area Strategy Groups in preparing their Area Waste Plans includes a detailed process outlined by SEPA in the supporting documents for the Scottish National Waste Strategy on how to evaluate and choose the BPEO for the area. Each Strategy Area Group identified 5 or 6 options, and evaluated and compared these using SEPA's national decision criteria covering environmental, economic, social, practicability and compliance with other policies; and through using a variety of techniques. In the Argyll & Bute and Forth regions, WISARD plus expert judgements were used. In Fife though (where they produced a Waste Issues Plan for consultation and not a full AWP) the process was a purely qualitative assessment

using a simple scoring of 1-6. They however indicated that further analysis would be carried out at a later stage, and no conclusions were offered as to what the BPEO might be. All 3 reports summarised their overall results, and 2 AWP's gave details of the results of the LCI analysis, and identified the BPEO. In the case of Forth this was a 2 stage BPEO, as the BPEO that met the first two Landfill Directive targets was different to that required to meet the third target.

- The Scottish process is very thorough but the results as shown in the AWP's do not fully reflect the promise that the process holds, as the data limitations faced by the SAGs restrict what can be achieved. Also because the process is so thorough and robust it can obscure these data limitations to some degree, and hence offer a conclusion that is given stronger validity than it might otherwise deserve. In Argyll and Bute the 5 options considered seemed to some extent limited in the choices they offered and constrained by an existing Public Private Partnership agreement and contractual arrangements, and no maximum recycling option was identified and no explanation as to why. Despite the thorough SEPA guidelines and process, very inadequate data severely limited what can be accurately predicted in the plan and hence achieved in planning process. This differed from the situation in Forth where a more balanced range of options was considered, although the problems with data limitations still existed.

2.3.6 Cost

- Only 11 English authorities consider comparative costs of different options or of their proposed waste management option in their strategy documents; however little discussion was included of how these figures were arrived at or on what data and assumptions they were based.
- The rest either do not discuss costs at all, mention it without any details given, or refer only to landfill costs; in some cases the strategy is 'contract based' and costs are not included for that reason.
- Both the Scottish AWP's examined included estimates of the capital and operational per tonne costs of each of the options considered; but again without any inclusion of the assumptions on which these were based.

2.3.7 Strategy summaries

The level of detail given in the proposed strategies discussed in these reports varied significantly from generalised aims and principles to be achieved through to prescriptive targets that need to be met. Table 2.2 below summarises the main elements of the strategies proposed by each authority.

Table 2.2 Summary of main points of strategy proposed by each authority:

Waste Authority	
English authorities	
Medway UA	<p>reduce waste going to landfill to 60% by 2004 by supporting recycling and composting</p> <p>improve cost effectiveness of bring site provision</p> <p>green waste collection at CA sites and extend green waste kerbside collection</p> <p>40% recovery should be by 25% recycling at least - look at new technologies in longer term</p> <p>costs of recycling services and treatment options included</p>
Surrey CC	<p>strategy closely tied to waste management contract</p> <p>increase recycling from 10% to 25% by 2005</p> <p>by expanding kerbside and improving CA sites</p> <p>build 3 MRFs;</p> <p>reduce landfill by 70%;</p> <p>2 EfW plants planned, with bottom ash recycling</p> <p>composting green waste throughout county</p>
Milton Keynes UA	<p>short to medium term up to 2007:</p> <ul style="list-style-type: none"> increase kerbside recycling to meet targets; re-introduce weekly kerbside of dry and begin free green waste fortnightly collections for composting increase recovery at CA sites continuing waste minimisation initiatives costs given for each option proposed <p>longer term plan to 2020:</p> <ul style="list-style-type: none"> introduce MBT or bio-drying or EfW process
Project Integra (Hampshire CC + Southampton and Portsmouth UAs and 11 WCAs)	<p>keep waste at '95 levels through waste minimisation</p> <p>40% recycling rate, including composting (first target was 25% by 2000)</p> <p>small EfW plants - 3EfW incinerators planned plus a possible Anaerobic Digestion plant in Southampton</p> <p>EfW capacity to deal with 50% waste</p> <p>overall cost implications for proposed increases in recycling discussed</p> <p>currently revisiting its strategy to 2020, as infrastructure to deliver current strategy recycling targets will be in place by 2005</p>
Essex CC	<p>local authorities favour high recycling and composting, and unfavourable to incineration</p> <p>public consultation on proposed 6 scenarios/options for future</p> <p>develop markets, through support for ReMaDe</p> <p>promote awareness</p> <p>evaluates cost for collection and disposal - including costs of trial area schemes</p>
Cambridgeshire CC and Peterborough UA (jointly with 6 WCAs)	<p>main thrust on increasing recycling and composting - refer to aiming for 60% rate</p> <p>focus on increasing kerbside with intensive bring where this not feasible</p> <p>accept need for other processes to reduce landfill but do not specify which preferred</p> <p>costs given for different options and waste treatment systems</p>

Bristol UA	<p>focus of the strategy choices is on waste disposal options</p> <p>assume recycling (25%) and composting (10%) = 35%</p> <p>integrated mass burn (12000t plant) considered to best meet objectives</p> <p>cost modelling studies carried out on the 6 scenarios</p>
Cornwall CC	<p>1 EfW plant centrally located for 60% of waste</p> <p>22% to landfill</p> <p>18% thought to be maximum achievable recycling rate (will not reach their target)</p> <p>some focus on centralised composting</p> <p>markets for dry recyclables considered a limiting factor and focus on developing these</p> <p>expand bring sites and some kerbside</p>
Gloucestershire CC	<p>EfW plant central to strategy</p> <p>landfill capacity only an issue as regards targets and BPEO</p> <p>waste reduction set as a target</p> <p>targets set for reduction of waste to landfill and for % of degradable waste being recovered</p> <p>consultant recommended going for EfW + recycling to meet targets but without contractual minimum tonnage in order to facilitate move to greater recycling in future</p> <p>includes costs estimates for the different scenarios</p>
Greater London Authority	<p>both a visionary strategy to 2020, and an operational strategy for up to 2005</p> <p>led by waste minimisation and recycling, and aims to and reverse growth in waste</p> <p>increase proportion recycled – encourage all WCAs to introduce kerbside or exceptionally intense bring systems, and improve recycling activity at CA sites</p> <p>for organic waste not home composted introduce separate collection for composting</p> <p>max reduction, recycling and composting before EfW considered – no need for more EfW before 2013</p> <p>clear presumption against incineration whilst waste minimisation and recycling are being developed</p> <p>opportunities for new jobs from recycling</p>
London Borough of Hounslow	<p>achieve maximum tonnage by kerbside schemes by extending schemes by numbers of households and by materials collected</p> <p>encourage maximum take-up of bring recycling, and add mini-bring sites for areas not suitable for kerbside</p> <p>achieve maximum tonnage of recycled + composted wastes at CA sites</p> <p>encourage prevention and reduction</p> <p>promote expansion of home composting</p> <p>increase awareness and understanding</p> <p>support moratorium on incineration until GLA addressed this issue</p> <p>improve participation</p> <p>introduction of organic/ putrescible/ green waste collections</p> <p>target to double the diversion of garden waste for composting by 2001</p> <p>costs included for collection, recycling and aspects of disposal</p>
London Borough of Lambeth	<p>conserve resources</p> <p>oppose incineration as primary means of waste disposal</p> <p>continue and improve kerbside and near-entry recycling for all residents</p>

	<p>extend range of materials collected</p> <p>community composting being trialled in 6 estate-based schemes</p> <p>encourage increased participation</p> <p>estimate that strategy will divert 28% by 2005</p> <p>include costs and benefits from the actions in their plan</p>
Staffordshire CC and Stoke-on-Trent UA	<p>considers waste arisings and how they will be landfilled</p> <p>assumes that approximately 20% will be recycled; 20% go to EfW and rest to landfill</p>
Birmingham UA	<p>based on existing contractual arrangements for the majority of MW to go to EfW plant</p> <p>mention of increasing recycling activity but minimal expansion of bring sites all that is considered likely</p> <p>kerbside feasibility studies to continue</p> <p>emphasis placed on recycling bottom ash to reduce waste to landfill</p>
Hereford and Worcester CC	<p>to meet targets for recycling and composting</p> <p>provision of source segregated dry-recyclable kerbside using plastic sacks</p> <p>provision of 3 MRFs + a mini-MRF for source segregated dry-recyclables</p> <p>2 composting sites for green waste from CA sites</p> <p>mixed waste MRF to include organic waste separation for an AD plant (for organic household + sewage)</p> <p>EfW plant</p> <p>waste minimisation strategy</p>
Cleveland (Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees UAs)	<p>increased recycling at CA sites - to 45% by 2005/6</p> <p>stabilise quantity of household waste generated</p> <p>encourage home composting (to 15% of households by 2005)</p> <p>meet targets for recycling of 10% by 2003/4, and 18% by 2005/6; but do not say how</p> <p>reduce MSW to landfill to 11% by 2003/4 and 8% by 2010/11</p> <p>EfW plant to take majority of waste</p> <p>recycle bottom ash</p> <p>consider mechanical separation of recyclables</p>
Durham CC with Sunderland and Darlington UAs	<p>waste minimisation education and awareness program</p> <p>improved HWRC bring facilities – develop super-sites which act as recycling and bulking-up facilities (mini MRFs for kerbside schemes)</p> <p>transfer stations developed as MRF-type facilities and incorporate AD</p> <p>composting in windrows of green waste as separate treatment system / have money for pilot AD plant / also want to</p> <p>pilot a pyrolysis + gasification plant</p>
Doncaster Metropolitan Authority	<p>key factor is for the strategy to contribute to the regeneration of most deprived communities in terms of development of community enterprises, support for new and existing businesses, creating jobs for socially excluded and general environmental improvements</p> <p>expand recycling at CA sites - to achieve 40% by 2003, and this will meet 2003/4 target of 10% recycling</p> <p>introduce kerbside pilot schemes through supporting community enterprise</p> <p>develop mini-recycling centres for high-rise areas</p> <p>expand but review bring facilities to improve effectiveness</p>

	<p>develop composting facilities in medium term, both the processing and collection aspects</p> <p>develop markets</p> <p>educational programmes</p> <p>current costs for collection and disposal for different services included</p>
Greater Manchester Metropolitan Authority	<p>waste minimisation is the primary approach</p> <p>17% recycling / 19% recovery by 2001</p> <p>25% recycling and 27% recovery by 2005</p> <p>30% recycling by 2006 rising to 35% and 40% recovery by 2006 rising to 70%</p> <p>recovery of value from unavoidable waste with EfW plant</p> <p>EfW plant planned for Bolton, now operational</p> <p>provide kerbside collection to all households for at least one material</p>
Cheshire CC	<p>set up Waste Task Group to take strategy forward</p> <p>concludes that BPEO is a three stream AWC (alternate weekly collection) for recyclables, green waste and residual, plus EfW in longer term</p> <p>waste minimisation and education strategy</p> <p>maximise recycling and composting</p> <p>review need for EfW in 2004</p> <p>evaluates cost of scenarios</p>
Scottish authorities	
Argyll and Bute SAG	<p>divert 27% of MSW from landfill by 2005, and 50% by 2010</p> <p>large scale composting of mixed MSW with mechanical separation of recyclables and non-biodegradable waste (MBT)</p> <p>increasing segregation at source over time</p> <p>beyond 2010 suggest BPEO will involve EfW plant - gasification or pyrolysis</p> <p>need for waste minimisation through awareness and education</p> <p>promote all forms of composting - home, small scale of segregated green at smaller landfill sites and MBT with front end recycling (up to 50% waste dealt with in this way)</p> <p>expand kerbside and bring recycling through community groups</p>
Forth SAG	<p>introduce recycling and composting schemes to 2006</p> <p>longer term by 2020 EfW plant</p> <p>waste minimisation supported, with some specific programmes and action cited</p> <p>improve recycling through source segregation (not mixed waste processing) but not specific as to how and suggest need to test best means from kerbside, bring or CA approaches</p> <p>ongoing assessment of new technologies for EfW plant to enable an informed decision by 2006</p> <p>working with SWAG (Scottish Waste Action Group) to identify public attitudes etc</p> <p>set targets of 25% household waste recycled or composted by 2006 (20% MSW) and 30% by 2010 (25% MSW)</p>
Fife SAG	<p>doesn't suggest overall future strategy; just presents 6 possible options and gives some preliminary BPEO assessments</p>

2.4 How Data is Used in Strategy Planning

A critical factor in the development of waste management strategic planning based on local information and local needs relates to how data is used to support the development of options and choices. This section evaluates how different authorities have demonstrated their use of data in their strategy plans; how their predictions and choices of strategies to meet their targets are based on local data; and what criteria they compare in evaluating policy options. It attempts to identify trends and similarities in approach, and examples of good practice in data use.

2.4.1 *How predictions for performance indicators and meeting targets are based on data*

- Only a minority of strategy plans use the data included extensively to justify their decision process or to support their conclusions; there are many more examples where data is included but not used to explore future options for waste management strategies; for example Medway discuss local performance indicators and evaluates these but doesn't base its planning on these factors.
- 8 authorities make use of scenarios to explore options, but not all explain how or why each of these options would meet the authorities targets or objectives; some though are evaluated in detail – for example the recycling rates assumed in Cheshire's strategy report are based on compositional analysis and assumed capture, and are then used to evaluate the BPEO; and Essex include waste flow diagrams for each of their scenarios from which performance criteria can be identified.
- Some authorities make use of available data, such as amounts collected and composition, to calculate how much material is potentially available for recycling or composting and hence what recycling or diversion rates might be achievable.

Hampshire have used both research findings and operational data on waste composition, waste arisings and diversion data to calculate capture rates and target the more effective capture of specific recyclables. They have included in their current strategy maximising recycling through their current infrastructure by increasing capture rates and achieving high diversion for kerbside and bring schemes in order to meet their recycling targets. Their focus on improving the performance of their current recycling infrastructure is based on careful evaluation of their performance data.

Cheshire's strategy makes good use of data and calculations to assess what might be achieved through different approaches to recycling, and calculates for different participation and capture rates, how much could be recycled and what recycling rates would be achieved; similarly for CA sites, their calculations are based on composition and % of each fraction they estimate to be recyclable; these calculations are fed into the options or scenarios that are then evaluated for BPEO.

Milton Keynes includes some use of data to calculate potentially available materials for recycling and composting, as well as to show how their policies will achieve BVPIs and targets. For instance their strategy plan includes calculations based on how much could be captured by achieving best recovery rates (but no rationale is included as to why these particular figures were used or from where they derived) with the amount of potentially recyclable material calculated using local composition analysis data.

Others that provide some calculation of potential recycling rates based on local data include: Cambridge and Peterborough; Bristol (although some statements are not substantiated e.g. suggest that max of 40% could be recycled without incurring excessive costs but do not explain where this comes from); Lambeth (uses composition data with weight data to predict potential amounts available, and combined with use of

capture rates look at increases needed to meet targets, and also includes calculation of how much waste could be home composted); GLA (uses composition and performance criteria to estimate what could be achieved in London); Birmingham; and Doncaster (includes some use of composition data to predict kerbside recycling performance, and in how targets might be met); and Greater Manchester.

Durham looks at what might be achieved through recycling in terms of overall capture rate for both kerbside and bring and CA sites; and translates this into tonnage; also looks at the infrastructure that would be needed to deal with residual waste and meet their recovery targets.

- Few authorities extend this data use to include the effect of participation on potential capture rates and hence diversion; Cleveland gives some indication regarding the amount of recyclables potentially available from composition studies, include some assessment of likely participation in recycling, and with data on the quantities in the waste stream, and estimates what might be captured.
- Some authorities use data to predict the amounts or tonnage of specific wastes that will be needed to meet their targets, but then do not take this further to look at how they will capture these amounts; many aren't specific about how they intend to meet targets – just state that is what they intend to do.

Surrey use calculations based on different recycling rates to say how much material will need processing and market opportunities, but do not relate this to how these rates might be achieved; neither do they explain how they intend to achieve the proposed recycling rates or how the capture of green waste is to be achieved.

Cambridgeshire and Peterborough discuss how much of their recycling target can be met by kerbside and how much through recycling at CA sites, as well as tonnages required for meeting the targets – but do not discuss how they will achieve the high capture rates proposed.

GLA refer to role that CA site recycling could play in overall achievement of recycling targets and support this with some general calculations.

Scottish AWP include only figures showing the tonnages that will be needed to be diverted to meet the Landfill Directive; Forth AWP doesn't specify how they might achieve the recycling/composting targets they set, only refer to calculations based on expectations of participation although no details are given to support this.

- Hampshire are exploring the most effective methods to achieve higher capture of recyclables through targeting publicity campaigns and exploring through trials the best way to capture green waste.
- Essex are have been running high recycling trials in 3 areas to find out if it is possible to recycle 60%, at what cost, and what the public reaction to such a scheme is; the trials are closely monitored with weights of refuse and recycling, environmental impact and participation all measured; some results were then used in assessing the 6 proposed options for BPEO evaluation and public consultation.
- The Cambridgeshire and Peterborough Data Sub-group made good use of modelling for estimating future waste arisings but this was not extended to recycling and other aspects of meeting targets; they propose increasing recycling rates to 60% but do not discuss how such rates might be achieved such as how to capture that much material, what participation rates are needed.
- The GLA strategy relates percentage of dwellings with gardens to home composting provision, and what might be achieved

2.4.2 What criteria are compared in strategy planning process

- In most cases little focus is given to justifying, explaining or giving data to explain why choices are made. Often strategy documents will only state that particular options *will* meet targets, and then focus on presenting the authority's other broader aims.

For instance Staffordshire and Stoke-on-Trent plan for a landfill capacity based on meeting national diversion targets but do not say how they intend to meet them and talk about monitoring recycling and composting activity but do not say how much currently exists or how they might need to increase this to meet their targets

- In many cases the choices made by the authority in their strategy plans are not clearly explained, at least as far as the factors considered in the overall decision, with no discussion of alternatives or justification of why certain options have been chosen. Some authorities just refer to a BPEO without justification or discussion of policy issues involved in this assessment.

Cambridgeshire and Peterborough are in this position, although they do look at service, environmental and cost factors independently, and consider risk (in terms of whether an option is a proven technology or not, and sensitivity to markets) – but they do not show how these criteria are compared, although they refer to developing a model for evaluating these factors to deal with future decisions.

- Several authorities consider a number of possible scenarios for future waste management systems and evaluate these using a number of factors and decision criteria to give them an overall 'best' option for their area; this methodology is used extensively by the Scottish Strategy Area Groups and by Cheshire to identify BPEO; it is also used in more restricted form in Gloucester, Bristol, Hampshire.

Bristol carried out a risk analysis on several future scenarios, and considered this alongside LCI and cost factors, more general economic issues and social-welfare especially jobs. Their strategy document sums up all options in a table, and concludes that smaller scale incineration EfW meets their objectives best, followed by local bio-treatment EfW. However they focus on the comparison of treatment options and are not clear what role recycling plays in evaluating the scenarios or how it is accounted for in the main report. As with many authorities they make no attempt to focus on improving the effectiveness of recycling and its consequent effects on LCI, cost etc.

Gloucester includes cost, technical and environmental impacts of each option, but in very general terms and refers to the consultants recommendation without giving any detail as to what the decision is based on.

In drawing up their AWP, the Scottish SAGs used the SEPA process on choosing the BPEO for their area; 5 or 6 options were identified and evaluated and then compared using 20 national decision criteria covering environmental, economic, social, practicability and compliance with other policies plus some additional local criteria. These criteria were evaluated using different techniques for each - plans refer to WISARD for LCI, plus expert judgements. The overall results were summarised, and using the evaluation techniques for comparing the different impacts, the BPEO identified.

Cheshire followed a similar process, identifying 6 options, plus the baseline one, and assessing them in terms of cost, environmental impact including transport, and a number of other factors; the county task group applied weightings to allow these criteria to be compared in order for the BPEO to be evaluated.

- In some cases strategy is based on the current waste management contract let by the authority, and the strategy documents give very little discussion to evaluating options or comparative impacts, and often no alternative are discussed e.g. Birmingham. Medway also leaves some discretion in choices of strategy to the approved waste management contract.

Surrey mostly dealt its waste strategy choices through its tendering process; they referred to asking the waste management industry to come up with solution, saying that they "threw down the challenge to the private sector to come up with innovative ways of managing Surrey's household waste ... didn't specify or identify a preference for any particular disposal or treatment methods or suggest any sites"; the contract was awarded to SITA, who set up Surrey Waste Management Ltd, but the authority do not say on what criteria they decided which tender to accept.

- Greater Manchester mention not exposing the authority to unnecessary technical or financial risk but no information is given as to what these unnecessary risks might involve.
- Hampshire is moving to the inclusion of waste management in Natural Resource Management (NRM); and it is likely that more authorities will begin planning for waste management in this broader context. NRM considers waste management as a part of wider resource management systems, and moves towards identifying wastes as potential resources.

2.5 Some Examples of Waste Strategy Planning in Europe, North America and Australia

This section briefly describes selected examples of waste strategies adopted around the world, with reference to their use of data and analysis to underpin the approaches taken. It attempts to give an indication of a variety of different approaches in reporting development of waste strategies. It is not a comprehensive survey, nor does it make direct comparisons of strategy planning between these plans and those of UK authorities. Such comparison at this level of detail is neither useful nor valid, as the external factors influencing these strategies are too many and too varied. The types of waste arisings for which authorities have responsibility vary from country to country, as do performance indicators used, and the legal, cultural and political frameworks in which they operate.

2.5.1 *Barcelona, Spain*

The Metropolitan Environmental Authority (EMMA) for the Barcelona Metropolitan Area, with a population of more than 3 million, produced and published a Metropolitan Plan for Urban Waste Management for 1997-2006, with an Annual Report on Progress published in 2000. These documents set the authorities overall plan based on the principle of sustainable development and citizen involvement. They committed the authority to achieving little if any increase in waste growth, and a steady growth towards 60% recycling (30% inorganic and 30% organic), with residual waste treated by 33% incineration and 7% landfill.

The published reports provide information on waste composition taken from local studies and analysis, waste weight data for total municipal waste and recyclables, and waste management infrastructure. However there is no information detailing why options were chosen, and no consideration of BPEO or LCI assessments, although it mentions the waste hierarchy. In general there is little attempt in the reports to justify how the policies proposed will achieve higher recycling and composting rates. They assert that improving provision will meet the targets set, but do not include data in the reports to support this.

2.5.2 Dublin, Ireland

The national policy framework for the adoption and implementation of strategic waste management planning in Ireland is expressed in 'Preventing and Recycling Waste: Delivering Change' a policy statement produced in March 2002 by the National Waste Management Board (NWMB). It is based on the waste hierarchy, sets targets for the next 15 years, and proposes a number of broad policy proposals to increase recycling of MSW from 9% in 1998 to 35% by 2013. Waste management performance indicators were not set nationally, and the NWMB asked to recommend what indicators should be adopted. The Irish EPA published national waste database 1998, and policy documents refer to the need for accurate and reliable data on quantities and composition.

The Dublin Region, covering one city and 3 county authorities, jointly produced the 'Dublin Waste Management Plan 1998', based on studies carried out by consultants. Its strategy covers 20 years, and includes:

- a minimisation policy with reductions in growth rates as targets to meet to 2011;
- provision of kerbside collection of recyclables to 80% of the population;
- provision of bring sites to areas where kerbside not provided;
- additional CA site provision, kerbside collection of household organic waste;
- provision of facilities to deal with source segregated wastes collected, and
- an EfW plant (but with max capacity of about 30% of waste arisings).

The strategy was agreed by all authorities, after public consultation to shape the evaluation of alternative strategies. This involved considering 4 scenarios and carrying out detailed cost and EI modelling for each scenario. EI included global warming, acidification, nitrification and photochemical ozone formation, heavy metals and dioxins. The plan referred to the choice of preferred option being by the BPEO, and including requirements to minimise landfill, maximise recycling, meet legal requirements, and be robust and secure option for future. The report however doesn't relate evaluation of BPEO or the choice of option to the results of the EI assessment.

2.5.3 Donegal, Ireland

Donegal County Council is part of the NW Region Cross-Border Group, and involved in regional planning for waste management. The regional group published a Strategy Development document in 1998, and the county plan 'Waste Management Plan Oct 2000' builds on this. A regional strategy is recommended despite cross-border differences in regulations causing some problems, and builds on policy in Ireland and Northern Ireland. The strategy recommends source separation of recyclables and additional facilities for composting, a regional MRF, and an EfW plant not exceeding 50% of waste arisings in area.

In justifying its strategy the report considered waste arisings and growth data, and estimated composition analysis. It considered 5 options, and analysed these against a set of targets (including national government, EU and cost targets) and decision criteria. They didn't consider EI or assess the BPEO.

2.5.4 London, Ontario, Canada

The City of London Municipality has had an integrated waste management strategy since 1997, called the 'Continuous Improvement System for Waste Management' and in May 2000 issued a summary report of progress. Their main strategy goals include minimising production of waste, minimising environmental burdens, minimising cost, and maximising opportunities to business. It is set in systematic framework that annually monitors the waste management

system for EI and cost, and considers community needs and priorities. It uses 4 key management tools and strategies: Integrated Waste Management software (developed in partnership with CSR (Corporations Supporting Recycling), EPIC (Environmental and Plastics Industry Council) with Procter & Redfern and Environment Canada); partnership programs with community and business; experiments and demonstrations; and communicating results. They achieved their primary goals by the end of 1999, by reducing waste *disposed* of by 36% between 1987 and 1999 (and which equates to a 31% recycling rate), with an overall budget for waste management including recycling costs quoted as one of lowest in N. America.

The model measures environmental improvement of their system using LCI analysis for all major materials in MSW. It provides comparisons of options in terms of energy consumption, greenhouse gas emissions, acid rain gases, smog producing gases, heavy metals and dioxins in air emissions and leachate, BOD of leachate, and residual solid waste.

2.5.5 *Nova Scotia, Canada*

Nova Scotia province produced a waste strategy 'Solid Waste Resource Management: A Strategy for Nova Scotians' in 1995, followed by a status report in 2001. The strategy has 4 main goals. These are to:

- achieve the Canadian Council of Ministers of the Environment's target of 50% diversion of solid waste from disposal by 2000;
- implement new disposal standards by end 2005 (landfill standards were very low in the province with 20 open burning sites still in use in 1996);
- achieve greater regional co-operation to reduce costs; and
- increase economic opportunities through recognition of waste as a resource and create jobs.

The 50% diversion from disposal (measured by amount of refuse collected per household for disposal) was achieved in 2001.

Although the goals established by the strategy require measurement and monitoring, the reports do not contain detailed data on how and what is being achieved, or why. There is no explanation as to why the programme was adopted, except in reference to achieving the Canadian target. The strategy mentions environmental improvement, but makes no attempt to provide evidence, such as use of LCI or assessing the BPEO, to support that policies will achieve this, or to measure by how much or in what ways.

2.5.6 *Edmonton, Canada*

The Canadian city of Edmonton (650,000 population) has adopted a 30 year Waste Management Strategic Plan, and the city's Waste Management Branch reports on progress on this plan in its '1999 Annual Report', and gives an update on performance in 2001 on its web-site.

The plan refers to a variety of data sources including some data on waste by quantity and type, performance indicators on customer satisfaction, cost/ household, and recycling rates, and studies on participation rates for kerbside recycling, including by socio-economic group. It is not clear though how these data are used to develop or support the strategy approach, or why the system chosen is the best approach for Edmonton. No discussion of LCI or BPEO assessments is included in the reports.

Their policy aims to meet the Canadian Council of Ministers of the Environment's target of 50% diversion of solid waste from disposal by 2000, and exceeded this by achieving an overall recycling rate of 68% in 2001, the best in Canada. This was achieved by 50% composting rate through the operation of its composting plant which co-composts MSW and biosolids, and 18%

recycling through kerbside collection of source separated recyclables. The composting plant takes mixed refuse, and no comment is made as to quality of final product and its use.

2.5.7 Canberra, Australia

Canberra is the Australian Capital Territory, but also a city with a population of around 100,000 households, but with a low population density. They were the first authority to adopt a 'Zero Waste' approach with their Waste Management Strategy, 'No Waste by 2010' agreed around 1996/7.

The strategy envisages that by 2010 "waste will have been eliminated" by producer responsibility and waste avoidance, reuse and recovery, creating new industries, and environmental education. It includes some data on waste arisings and recycling rates, claiming the highest participation (98%) and recycling rate for any kerbside scheme in Australia. However it doesn't specify what the recycling rate is, or give details of the waste management infrastructure. Elsewhere it has been reported that in 1998/9 Canberra recycled around 57% of its municipal waste, however the vast majority of this is through demolition wastes, and without this fraction the recycling rate for MSW is reduced to around 29%. Neither does the strategy include discussion of why zero-waste brings environmental or other benefits, although it does refer to future need for waste inventories, benchmarks and progress reports.

2.5.8 California, USA

California State Integrated Waste Management Board published a draft strategic plan in November 2001, building on their 1997 waste plan. It adopts a zero-waste philosophy, and its key themes are sustainability, product stewardship, energy recovery, environmental justice and safe disposal of waste. The 1997 Plan was on target, having prioritised helping authorities reach 50% diversion goal, it raised California's overall diversion to 42% in 2001. This represented a 65% jump in diversion from 1997-2000. The 2001 Plan sets higher standards, but the focus has shifted to a "broader, more systematic approach to managing materials used and created in manufacturing" and "working toward achieving a sustainable society".

The report concerns general principles focussing on vision, mission aims and values rather than analysis of what and how to implement policies, how to achieve goals and what environmental impacts of these policies might be.

2.6 Summary and Conclusions

Looking back to the list of waste data that DEFRA, in its guidance to local authorities in England, suggests should be included in Municipal Waste Management Strategies, it appears that most authorities do not cover these criteria fully. All of the documents examined contained an incomplete set of data by this standard. The majority include details of the total amounts of household and municipal wastes handled, civic amenity site wastes, and materials collected for recycling, plus projected waste growth, and information on the infrastructure provided and planned. Most refer to their recycling targets and whatever plans they have to meet these, but few include any specific analysis of how their proposals will achieve improved recycling rates or meet their targets. Often the documents just refer to these proposals leading to the desired increase without any particular justification or explanation as to 'how'.

Most authorities refer to the problems and barriers they face in meeting government targets and in their waste management planning, and these often include a lack of data. However this is not the only issue they are concerned about, with political, economic and contractual factors also featuring as obstacles to planning effective integrated systems. Financial constraints vary between authorities but are a constant factor in limiting options available in practice to most authorities. The Greater London Authority made an interesting comment in this context: "Social

exclusion is a potential barrier to recycling but it is likely to have more to do with the budget priorities of the local authority, than the unwillingness to recycle by those living in areas of deprivation. Those on low incomes are often very good at recycling".

The GLA also argues for a change in the structure of waste management planning to allow overall planning for London with a single waste authority, saying that the current situation is fragmented and lacks coherent overall policy. Another key dilemma highlighted by both Hounslow and Lambeth relates to WCA developing their strategy without the context of a disposal strategy from their WDA. Another aspect of the structure and organisation of waste management planning concerns contractual arrangements. Those already in place can limit an authority's ability to successfully plan for sustainable and integrated waste management and can place constraints on available options. An example is Cleveland which has a contractual arrangement running until 2020 for 62% of their total MSW to be delivered to an EfW plant and a further 27% to landfill. This doesn't leave them with much scope for diversion without incurring financial penalties.

A positive driver for an integrated sustainable approach to strategic waste management planning was identified by Wilson *et al* (2001) as whether waste managers were considered to be operating a waste disposal system or a resource management system. This change in attitude and context of waste management is beginning in the UK. Project Integra in Hampshire, is one of a few councils, developing a Natural Resource Management (NRM) approach, which involves a move towards identifying all wastes as potential resources. Such an approach will lose some of the distinctions between municipal, household, industrial and commercial waste, and move towards identifying particular material types and how they can be best utilised. This approach to waste management is close to that adopted by the 'Zero Waste' movement (Warmer, 2001), which aims to work towards eliminating waste rather than managing it, through better resource management. SEPA is also taking a whole waste approach and specified that Scottish authorities should consider all wastes in their area - industrial and commercial as well as municipal - but to concentrate on municipal waste and wastes handled by the authority in first instance. However none of this can be effectively achieved without adequate available data.

The focus of this review of waste management strategy planning, has been to identify how data is being used by local authorities in their planning and decision-making, and from this how it might be better used. A number of authorities refer specifically to their need for better data. Lambeth comment on the need for more recycling data and waste auditing to improve targeting. The GLA referred to setting up a database for waste information that will inform future strategy planning. All the Scottish authorities considered in this Chapter referred to incomplete data being available; and many more authorities indicated a lack of information concerning one or more aspects of their planning.

In addition to data on overall tonnage of wastes handled, about half of the authorities include information on composition of municipal or household waste. But for these, this data refers to RCV collected refuse and recyclables, in all cases except for Milton Keynes and Hampshire where compositional studies of CA site wastes were also mentioned. Little attempt is made by authorities to integrate collected waste data with that on waste and recyclable materials collected through CA and bring sites. In most cases compositional data is either not available, or not in a comparable format that it might be used to build a complete picture of the waste arisings and composition. Such a picture though is critically important in planning collection methods and infrastructure to provide an integrated approach to meeting targets, and achieving a more sustainable approach to waste management.

Another aspect of information necessary in evaluating performance of source segregation recycling schemes is participation, both in terms of how many participate and how effectively

they capture the targeted materials. Very few authorities consider participation rates in their planning documents. But for recycling rates to improve, there is an urgent need to plan specifically for improving the effectiveness of recycling schemes. By using data on participation and capture rates, with locally-based compositional data for the whole household or municipal waste stream, it should be possible to identify where improvements can be made, and to plan more effectively.

The answer to the question “to what extent does understanding of waste stream and waste composition determine strategy planning?” from this study must be very little. Yet it is clear that for an integrated, sustainable approach to waste management to be successfully developed for any area or authority that such an understanding is vitally important, together with an understanding of how this data could be better used to underpin decision making in strategy planning. To allow this to happen, local authorities will need to improve their data acquisition and monitoring. The types of data needed to effectively plan integrated waste management strategy at a local level and allow more accurate projection of future strategies, are also mostly essential elements in monitoring performance & cost. These should include, in addition to standard operational data on tonnage collected by waste type and source (such as ‘round’ data) and infrastructure information (including detail such as the number of vehicles that service kerbside and refuse collection rounds and numbers of households served):

- information on waste composition for the whole municipal waste stream;
- measured data on kerbside participation – both overall participation rate (measured over four-weekly period) and set-out rates, with attention being given to the selection criteria for getting participation data, including how areas might be classified to compare and contrast performance; how to collect data in way that allows participation by material to be assessed as well as numbers of participants; and timing of measurements;
- public attitude surveys;
- CA site surveys and catchment area and use information;
- socio-demographic information – such as Council Tax banding by postcode, and the use of GIS to map data on performance factors, socio-economic information with site location and use patterns and round data;
- projections for increases in waste arisings, and what the basis for these calculation are.

To collect this data will require a framework for improved monitoring by most authorities, as well as in some cases research and experimentation, such as carrying out well defined trials designed to allow thorough comparative evaluation of different processes and techniques.

Although every waste management authority included in this research used the term *integrated* repeatedly, this was not necessarily reflected in practice in an integrated approach to either the planning process or the systems proposed to provide the future basis for waste management in their area. Most mention taking into account a number of factors including not only cost, but ability to meet Best Value targets, to satisfy political or social considerations, the overall environmental impacts, and seeking the Best Practicable Environmental Option (BPEO). However it is rare to find an authority which appears to attempt to integrate these multiple criteria in its decision making process.

The majority of strategy plans considered, even those that considered identifying the BPEO as an aim, based their priorities on the ‘Waste Hierarchy’. Many strategies begin by discussing tackling waste avoidance or minimisation, and then consider what source segregation plus recycling and composting can achieve, or simply assume they will try to achieve as much as they practically can in this way. If these measures are not considered adequate to meet the authorities obligations for diversion from landfill then plans for Energy from Waste (EfW) processing or alternative biological treatments, as the next prefer option, may also be discussed,

in addition to provision for landfill. The fairly universal acceptance of the 'Hierarchy' as offering the preferred environmental solutions, from many sources including government publications, together with the simplicity of approach it offers, and the fact that priorities can be set without the need for extensive information needed, explains its popularity. However it has considerable drawbacks as an approach to *integrated* waste management. With better information it should be possible to move forward to consider more complex models for evaluating combinations of processes to optimise the treatment of the whole waste stream, taking into consideration interactions between the demands and requirements of each option. Scenario building in order to evaluate and compare options is one effective way to make better use of available data.

Identifying the waste management system that is the BPEO for the area through LCI and cost evaluation offers a more integrated approach. This allows a more thorough assessment of environmental impacts, but equally can be of limited value as the BPEO can only be reliably identified if good information and particularly locally accurate data is available to carry out the LCI analysis.

Chapter 3 — Source Segregation, Bring and Kerbside Collections

Source segregation of municipal waste is an important component for planning and delivering Integrated Waste Management (IWM), and its adoption is likely to increase further over the next few years. It is considered a “necessity” to meet recycling and composting targets (HoCETRA, 2001), and a Draft Recycling Bill has been presented to Parliament, calling for a doorstep recycling service for all households by 2010. In light of the importance of source segregation and its connection with many of the issues discussed in Part 2 of this Report, this Chapter provides a background and review, which details general factors affecting source segregation and collection.

3.1 Types of Collection Systems

Municipal waste has a heterogeneous composition and, therefore, material suitable for recycling and composting needs to be segregated or separated from unsuitable material. Segregation implies that material targeted for collection is kept separate from other waste, whereas separation implies that target material is removed from other waste. However, in practice the terms segregation and separation tend to be used synonymously to refer to material for recycling or composting that is generally put apart from residual waste. Source segregation takes place at the point of discard of the waste, prior to collection either from bring sites or the kerbside. This can include segregation in the household (by the householder) and at the kerbside (by the collector) e.g. the kerbside segregation of ‘blue box’ co-mingled recyclables.

The materials targeted for recycling and composting vary between particular schemes, although both bring and kerbside usually target one or more of the following materials: organics (garden and/or occasionally kitchen waste); paper (newspapers and magazines); plastics; glass; metal (cans) and textiles. In terms of Integrated Waste Management and national recycling/composting targets, it is important to be aware of the approaches and facilities employed in collecting a range of household waste types so methods identified for all relevant materials are reviewed.

Bring schemes and kerbside collection schemes are the two main collection methods for source segregated recyclables and compostables (Atkinson and New, 1993). While bring schemes continue to play an important role in collecting specific materials for recycling, kerbside collection is rapidly becoming established. This is especially true for dry recyclables, where DEFRA statistics show that the proportion collected from CA sites has decreased from 84% in 1995/96 to 64% in 2000/01, with kerbside collection increasing from 16% to 34% (DEFRA, 2002; NAW, 2003). In contrast, 89% of organic household waste collected for composting was collected from CA sites, and 11% was collected from the kerbside in 2000/01, and this proportion has remained relatively constant over the last few years.

3.1.1 *Bring systems*

Bring systems are also known as fixed point systems or drop-off centres, and they comprise large recycling containers in easily accessible places, such as civic amenity sites (increasingly known as household waste recycling centres) and supermarkets. With the increased emphasis on re-use, recovery and recycling some authorities now refer to bring sites as Household Waste Recycling Centres or Community Recycling Centres. The public are encouraged to sort recyclables from the waste stream and deposit them into specified containers. As with most municipal waste management practices, there is usually no direct charge for this service. A variety of containers are used depending on location and fill rates, and these are usually

served by the Waste Disposal Authority or contractors acting on their behalf. Bring systems are now operated by virtually every authority in England and Wales (Audit Commission, 1997), and seem set to continue as an important collection mechanism (Coopers and Lybrand, 1993).

Despite the widespread adoption and variety of bring schemes, most target dry recyclables, such as glass, newspapers and magazines and textiles. Bring schemes for household organics are limited to 'green' (garden) waste containers at civic amenity sites. For instance, DEFRA statistics suggest that in 1999/00 there were over 15,500 bring sites for dry recyclables (i.e. not including garden waste), mostly situated at frequently visited public locations. In contrast, there were just over 600 civic amenity sites accepting garden waste (DEFRA, 2001). Despite a lower availability of organic bring schemes compared to dry recyclables, this is currently the dominant route for diverting organics from landfill.

High-density systems (a small number of households per facility) are usually located within a short walking distance of households. High-density bring schemes offer an alternative for dwellings where source segregation and kerbside collection may not be appropriate, e.g. blocks of flats. To date, high-density bring schemes have not been widely introduced in the UK, although there have been a number of pilot schemes (e.g. Fielder and Birley, 1996). In areas of Europe and North America that have relatively high recycling and composting rates, high density bring sites have been an important collection method, sometimes complemented with kerbside collections (EC, 2000; Favoino, 2000). One of the most important factors affecting the use of bring sites appears to be their proximity. An Italian study found that 70% of households participated in a bring scheme for dry recyclables where facilities were within 100 metres of their home, whereas participation dropped to less than 15% where distances were greater than 800 metres (ERRA, 1996).

3.1.2 Kerbside collection systems

In kerbside collection schemes, householders are encouraged to segregate targeted recyclables from their general waste and deposit this at the kerbside for regular collection. There are a wide variety of different schemes in operation, which collect either one dedicated material (e.g. paper/card, or green waste) or co-mingled material (several different types of recyclables in one container, such as paper, plastics, metals, already segregated from general waste by the householder). Most schemes fall into one of the following categories:

- Kerbside sort: co-mingled material second sorted into a multi compartment vehicle at the kerbside;
- Co-mingled single stream: variety of different recyclables placed into one container by the householder, and collected from the kerb in a single compartment vehicle for centralised sorting at a material recycling facility (MRF);
- Co-mingled multi-stream: different recyclables are segregated and placed into separate containers by the householder, and collected from the kerbside in a multi-compartment vehicle;
- Co-collection using split bodied vehicles: wheeled containers with split compartments, or separate wheeled bins/sacks are collected at the same time from the kerbside and emptied into a split-bodied vehicle, or collected in a separate vehicle
- Single sack schemes, such as Survival sacks: material for recycling is separated into a coloured plastic sack by the householder, and is collected at the same time as the general waste by the same vehicle. The sacks are then removed from the general waste for onward recycling prior to disposal of the general waste.

Household organic waste is usually collected as a dedicated material, i.e. not co-mingled with other recyclables. This necessitates less sorting than dry recyclables, i.e. no kerbside or central sorting is required, although removal of obvious contamination, either at collection or at the composting site, may be carried out prior to shredding and composting. Clearly less sorting will help reduce the costs of operating a scheme, although this will need to be offset against other collection costs.

Some schemes may use more than one of these segregation systems, for example the first sort is conducted by the householder (e.g. paper and card separated from co-mingled plastics, metals). Co-mingled recyclables are then second-sorted into a multi-compartment vehicle at the kerbside, the contents of each compartment then undergo a third sort at the materials recycling facility (MRF).

There is no one 'best' type of kerbside scheme, appropriate options will depend upon a number of factors, including the aims and objectives of the scheme, existing or planned collection systems and infrastructure, processing facilities available, target materials and available markets. Contextual issues such as local demographics and contractual arrangements will also affect appropriate options.

In designing schemes authorities should also account for the dynamics between bring and kerbside systems. Kerbside collections are likely to divert some household waste from civic amenity sites, which could reduce the recycling and composting rates under the control of the WDA. For WCA (i.e. non-unitary areas) diverting a separately collected waste stream from the control of the WDA to their own control, will increase the WCA recycling rates but may also be interpreted as an increase in overall waste arisings (especially if WCA data is not consolidated with WDA civic amenity data).

The increase in source segregation has given rise to the concept of integrated collection systems. According to the Audit Commission (1997) integrating kerbside collection of recyclable material with the residual waste collection service "offers both financial and environmental benefits". There are different interpretations as what integrated collection systems refer to. According to DEFRA (2001) and the Institute of Waste Management (IWM, 2002) integrated systems refer to collections where recyclables are collected at the same time and in the same vehicle as the general waste. This includes split bodied vehicles, which have discrete compartments for the different waste streams, or the collection of survival sacks with the general waste. Recyclables that are collected separately from the general waste are referred to as separate, rather than integrated, collections. However, separate collections are sometime referred to as part of an integrated systems where the collections of recyclables diverts sufficient quantities from the general waste stream to allow for reduced general waste collections, for example alternate weekly collections of recyclables and general waste (Curry, 1999; Audit Commission, 1997).

3.2 Factors Affecting Source Segregation and Collection Systems: Public Participation

Securing public participation in source segregation is an important element for successful schemes. Chapter 5 looks at the implications of different participation rates on recycling performance, whilst this section discusses some generic participation issues.

Participation in segregation and collection schemes is subject to a complex range of factors, and there is little consensus on the prime determinants of recycling behaviour (Tucker *et al*, 1997). Assessments made against a single dimension such as behavioural factors or socio-demographics are likely to mask relationships within this complexity. However, accessibility and convenience appear to be generic factors facilitating segregation and collection, which need to be carefully addressed when designing a scheme. Studies in the US and Europe suggest that participation is encouraged through convenience factors such as container provision, collection

frequency and communication strategies. In addition, many areas with relatively high recycling and composting rates rely on mandatory participation in collection schemes, and may utilise economic incentives such as user pay systems.

The issue of participation has been one of the most researched areas surrounding recycling schemes. Generally speaking, research can be classified into two main areas: investigation into behavioural factors to identify individuals more likely to participate and the influences on rates of participation; and more extrinsic factors focusing on barriers to participation and overcoming these barriers, particularly through scheme design and implementation. Behavioural factors comprise both intrinsic psychological factors and socio-demographic factors. Design factors include participation criteria (voluntary or mandatory); container provision and collection frequency; materials targeted; communication and information provision; and economic incentives. However these classifications should not be regarded as comprehensive or mutually exclusive since they overlap and are sometimes linked. Some key factors relating to public participation in source segregation and collection schemes are discussed below.

3.2.1 *Participation in bring systems*

Despite the widespread adoption of bring systems, participation tends to be lower than in kerbside collection systems. Following the monitoring of four authorities committed to implementing bring systems as a means of achieving the UK Government target, Warren Spring Laboratory found that the diversion rate achieved through bring recycling was less than 10% by weight (Atkinson and New, 1993). Although this is a low recycling rate, the authorities did record a small net income, largely due to the provision of recycling credits for the avoided landfill costs (*ibid.*). Inconvenience, in terms of storage and access, is often cited as a barrier to using bring schemes. An investigation into the poor use of bring systems in Plymouth revealed that one of the main factors limiting use was that 40% of households did not have a car (Audit Commission, 1997).

European experience, particularly from Germany, The Netherlands, Denmark and Italy, shows that accessible high density bring systems are capable of achieving high participation rates (around 70%), with recovery rates ranging from 15 to 36% (ERRA, 1996). Fielder and Birley (1996) conducted research into two pilot estate schemes in Sutton and Sheffield, which targeted dry recyclables. Average participation rates were recorded as 16% and 39% respectively, although this masked vast differences between participation from individual blocks of flats according to proximity to the recycling facility.

Whilst the potential to reach high diversion rates with low-density bring sites is limited, they are likely to continue as an important mechanism for the collection of recyclables and compostables, complemented by other systems such as high-density bring sites and kerbside collection.

3.2.2 *Participation in kerbside schemes*

Participation rates for kerbside schemes are not as well measured or known as might be expected given that this question has been extensively researched. Many individual scheme rates have been measured, and rates cited cover a wide range. Participation rates quoted in the UK DETR/Waste Watch (1998) 'Good Practice Guide' for 19 local authority kerbside schemes where in the range of 40-99%, with the mean participation rate found to be 63%. In another study carried out in Bristol, kerbside participation rates in the range 26-74% were measured (Mansell, 2001).

Tucker (2001) looked at participation in a number of newspaper-only collection schemes, and found significant variations between participation at individual street level from less than 20% to more than 70% measured, with most in 30-60% range.

3.2.3 Behavioural factors

Pro-recycling attitudes, values, and beliefs appear important recycling behaviour antecedents. Altruistic motives are likely to provide significant incentives for participating in source segregation schemes, and recyclers tend to be more aware of the environmental issues surrounding recycling than non-recyclers, although recycling behaviour is not necessarily correlated to general pro-environmental or positive ecological attitudes (Derksen and Gartell, 1993; Vinning *et al*, 1992; Oskamp *et al*, 1991; Vinning and Ebreo, 1990; De Young, 1986). To encourage participation in schemes it is important to provide information on both the 'why' and 'how' of recycling, and there is some evidence to suggest that participation is capable of changing recycling attitudes, and participants may become more strongly convinced of the benefits of recycling (Kilner, 1992).

In addition to attitudes and values, normative influences (e.g., social pressure or social encouragement from family, friends and neighbours) may also be important for encouraging participation in recycling schemes. If there is high visibility and a 'critical mass' of recyclers, these can act as catalysts, encouraging non-recyclers to participate (Everett and Pierce, 1992; Oskamp *et al*, 1991; Granzin and Olson, 1991). However, the role of normative influences is far from clear, as other studies have found they are not a significant recycling motivator, especially in established schemes (Perrin and Barton, 2001; Taylor and Todd, 1995; Vinning *et al*, 1992).

3.2.4 Socio-demographic factors

Several research studies have investigated the relationship between socio-demographic factors and recycling behaviour. Affluence in terms of size of residence, area and income, and education have been found to be positively linked to recycling behaviour (Watts and Probert, 1999; Berger, 1997; Coggins, 1994). However, other studies have found that there is not a strong association between housing type, income and education and recycling participation (Tucker *et al*, 1997; Vining *et al*, 1992; Neuman, 1986).

Using single dimension variables, such as behavioural factors or socio-demographic factors to investigate recycling behaviour may not be the most meaningful, as they are likely to simplify a complex set of factors and mask dependencies. More meaningful analysis of participation and scheme performance could be achieved by using a combination of key waste management design variables, such as containment method, collection frequency and density of bring sites (Parfitt *et al*, 2001).

3.3 Factors Affecting Source Segregation and Collection Systems: Design Variables

A frequently cited factor constraining recycling activity is inconvenience, including perceived time and effort to sort recyclables, storage requirements, perceived ineffectiveness of action and recurrence of old habits (Perrin and Barton, 2001; Vinning *et al*, 1992; Oskamp *et al*, 1991). There is also some evidence to suggest that participating in the sorting and storing of recycling reduces the perception that recycling is impractical and inconvenient (Kilner, 1992).

To secure participation it is important that collection schemes are designed to be as convenient as possible, issues which are also explored in Chapter 5. In terms of bring sites this may include the proximity of the site, the types of material accepted, and management of the site, so that containers are accessible, emptied frequently and the site kept clean and tidy. Kerbside collection schemes contain a number of design variables that can be aimed at improving convenience, efficiency, and participation. Design variables are particularly important in determining the costs of a scheme and it should be recognised that once operational, some scheme designs may be inflexible. Clearly, a detailed knowledge of the fractions making up the waste stream is important at the design stage so that materials can be effectively targeted, and

this is discussed on detail in Chapter 6. This following section outlines some of the important variables to be considered in designing source segregation and kerbside collection schemes.

3.3.1 *Voluntary (opt-in) vs. mandatory (opt-out) participation*

Many North American and European states have legally enforceable requirements to separate household recyclables and/or organics at source. These requirements tend to be set at the municipal level, usually in response to mandatory recycling rates implemented at state level, e.g. Canada, Germany, Denmark, Austria, The Netherlands (MacDonald and Vopui, 1994). In the United States, over half of all recycling schemes are based on mandatory participation, and the literature shows that mandatory kerbside schemes achieve higher levels of participation and material recovery than voluntary schemes (Folz, 1991; Platt *et al*, 1991; Everett and Pierce, 1993; Noehammer and Byer, 1997). In one study of 630 dry recyclable kerbside collection schemes in the US, it was concluded that “mandatory participation appears to be the most significant program parameter” (Everett and Pierce, 1993, p59). Other studies have shown that whilst mandatory schemes tended to perform better, well designed voluntary schemes can achieve similar levels of participation, and comparable or higher quantities collected per participating household (Slater, 2003; Noehammer and Byer, 1997).

3.3.2 *Container provision and collection day/frequency*

Another important design feature is container provision, which increases convenience and results in higher participation and recovery levels. The lack of container provision has been shown to be a primary reason for poor participation, and removal of a free collection sack has been found to lead to a 50% reduction in participation (Tucker, 1999; Everett and Pierce, 1993; Noehammer and Byer, 1997; Ball and Tavitian, 1992). Container provision appears to be more significant for voluntary rather than mandatory schemes, possibly because, in the absence of legislation, free container provision encourages participation (Folz, 1991). For organic kerbside collections, a small receptacle for kitchen organics as well as a larger container for storage is sometimes provided to promote convenience.

Collection day and frequency will also impact upon participation. Collecting recyclables on the same day as general waste collection is likely to be more convenient for the householder than collection on a different day. More frequent collections are also likely to be more convenient in terms of storage and recall, and moving from monthly to fortnightly collections has been shown to double recovery levels (Noehammer and Byer, 1997; Everett and Pierce, 1993).

3.3.3 *Target material*

Chapter 6 discusses the importance of local waste compositional analysis in deciding on target materials. The objectives of the scheme will be important in deciding target material. For instance, whether the scheme is designed to maximise waste diversion (e.g. target the largest waste fraction, typically paper and organics) and/or to optimise economics (target steel and aluminium as good, stable markets for end products). It is important to note that schemes designed to target garden waste need to take account of seasonal fluctuations (Woodward *et al*, 2001). Perrin and Barton (2001) found that material type affected recovery efficiency, with a higher recovery level for materials such as newspapers that do not require immediate storage and can be disposed of in bulk from various storage locations around the house.

3.3.4 *Household economic incentives (charges or rewards)*

Households are more likely to participate in source segregation schemes if they have an incentive to do so. Direct variable charging, where householders are charged according to the amount of waste they produce, is well established in many area of Europe and North America.

In areas of Germany, Belgium, Sweden, Switzerland, Italy, and Luxembourg user-pay systems are mandatory. Swiss legislation explicitly follows the polluter pays principle, requiring Local Government to ensure that costs are through fees borne by those who produce the waste. Many schemes that use direct variable charging for general waste levy reduced or zero charges for the collection of recyclables to encourage participation. Overseas experience suggests that variable charging designed to encourage participation in recycling dramatically increases source segregation and recycling rates (Ernst & Young, 2002; Kelleher *et al.*, 1997; Miranda and Aldy, 1996; Platt *et al.*, 1991).

The issue of variable charging in the UK is likely to be widely debated. At present WCAs have a legal obligation to collect general household waste without making a direct charge to the householder, although they can levy a charge for certain categories of household waste, including garden waste. Charging for garden waste collected for composting may seem attractive to authorities as a way of off-setting some collection costs, but does not provide an economic incentive for participation. The Strategy Unit has recommended that whilst it would not be appropriate to introduce a uniform national charging system for general household waste, the Government should take legislative measures to grant local authority the powers to introduce variable charging if they wish to do so.

There have been several studies in the UK which have piloted different incentives and rewards to encourage waste reduction and participation in recycling schemes, which are detailed in the Strategy Unit's report 'Waste not Want not' (2002). Balby District Council in Leicestershire recorded a 55% increase in the amount of recyclables collected at the kerbside following the introduction of variable charging for general waste collections.

3.3.5 Communication and information provision

Communication strategies and information provision is an important element in securing participation in recycling schemes, and in affecting how well participants understand the scheme requirements, which is discussed further in Chapter 5. Householders need clear and simple messages to encourage participation. Public information and education campaigns should not be one off but should precede the introduction of the scheme and continue during and after implementation. Feedback on performance and re-enforcing positive elements of the scheme are also important, and many successful schemes have found that personal contact, such as road-shows and home-visits, are invaluable for getting the recycling message across to the householder and promoting waste awareness generally (Stillman, 2000; Read, 1999).

3.3.6 Costs of source segregation and collection systems

Collecting reliable data on the costs of kerbside collection is notoriously difficult, which is partly because so many factors influence collections costs, including contractual arrangements, scheme location and design, and capture and participation rates. There are also many different criteria used by authorities in calculating and reporting costs, which limits comparative analysis. To try and overcome this, both the former DETR (1997) (now DEFRA) and the Audit Commission (1997) commissioned or carried out independent verifications of the costs of recycling collection (the DETR survey also included processing costs).

The Audit Commission used detailed cost information from 21 kerbside recycling schemes, and detailed results on a cost per tonne and cost per household for gross and net costs (i.e. after recycling credits and income). The results show gross kerbside collection costs ranged from £41 to £290 per tonne, and bring systems ranged from £13 to £97 per tonne. The average gross kerbside collection cost was calculated as £143 per tonne and net costs at £107 per tonne, and the average gross bring system at £47 per tonne and net costs at £17 per tonne. The DETR survey concluded that the net costs of kerbside collection ranged from £13 to £69, and the net

costs for bring systems ranged from a surplus of £5 to a cost of £123 per tonne. Other surveys of schemes suggested the most common kerbside collection costs ranged from £50 to £70 per tonne (Dennison and Dodd, 1998), and from £85 to £240 per tonne (Ecotec, 2000). These examples illustrate the wide disparity in estimating collection costs. Some of the reported variance is likely due to inconsistencies in parameters used to calculate costs and some may be explained through effective design, implementation and participation levels

Problems associated with comparative analysis at the national level become even more complex at the European level. In their cost-benefit analysis of municipal solid waste management options, Coopers & Lybrand (1996) offer net costs for various bring and kerbside collection systems for different EU member states. Eight different schemes are given for twelve member states. The lowest cost is a high density source segregated bring system in the Netherlands (25 ecu/t) and the highest is low density kerbside collection of source segregated recyclables in Denmark (656 ecu/t). Generally speaking, countries with a high level of recycling incur the greatest costs for all collection systems; e.g. Denmark, Germany, the Netherlands and Belgium. Cost relatives between Member States are broadly consistent across different methods. Variations between countries for some of the collection schemes appear relatively small, e.g. the lowest cost for high-density kerbside collection of source separated recyclables is 63ecu/t (Portugal) whereas the highest is 103ecu/t (Denmark). Overall, the Coopers and Lybrand study showed several kerbside collection cost trends. The costs of source separated kerbside collections in low density areas are significantly higher than in high-density areas (4-7 fold increase for each country). Kerbside collection of source separated recyclables is more expensive in each country than the kerbside collection of co-mingled recyclables. Collection in rural areas is more expensive than urban areas.

The conclusions from these surveys show the wide range and disparity between estimates of kerbside collection costs. This disparity and lack of comparable information on collection costs provides no help for individual local authorities in estimating the costs of implementing alternative collection systems in their own WCA. A different approach, in which the costs of the different systems are standardised, has been developed to evaluate if it provides a method to compare the costs of different systems (Hummel, 2002). This standard cost approach involves applying standard unit costs to infrastructure variables. In this way comparable costs are established for the different systems. Analysis of the standard costs shows that there are some trends in the collection costs for kerbside collections currently operating. Further discussion of this standard cost approach together with practical examples is detailed in Chapter 7.

3.4 Conclusion

This Chapter has reviewed source segregation and collection schemes, and has introduced some of the generic factors that influence participation and should be considered when designing collection schemes. A number of these factors are developed in the context of gathering and utilising locally based data for planning integrated waste management strategies in Part 2 of this Report, including understanding public participation, gathering compositional data, modelling residual waste streams, building scenarios and illustrating a standard cost methodology.

Part 2

Information Needs and the Role of Locally Based Data in Developing IWM Strategies

Chapter 4 — Geographical Information Systems and their Potential Application for Informing and Delivering Waste Management Strategies.

4.1 Introduction

Most public service delivery involves decisions about spatial or location factors. Geographical information systems (GIS) are used increasingly by central and local government in a range of areas including land-use planning and management, health and transport planning, and urban regeneration. All local and central government departments have access to digitised datasets, and most have established GIS software systems and technical expertise. However, GIS has been used rarely by local authorities for managing waste and recycling. A number of authorities were contacted during the course of this research, and although several expressed interest in developing GIS for waste management strategy and planning, to-date GIS has been used for waste management strategies on an experimental or trial basis, if at all.

The purpose of this Chapter is to explore the potential usefulness and application of GIS techniques for developing waste strategy plans, and in enhancing waste service provision and delivery. The first section of this Chapter considers the nature and basic principals of GIS systems, including components, analysis and applications. The second section reviews the use of GIS in relation to waste management, and offers a number of potential applications for informing and monitoring waste management and recycling strategies.

4.2 Applications of GIS and its Use in Planning

4.2.1 *Definitions*

Computer mapping from data sets has been under development since the late 1960s (Rhind, 1987), and since the emergence of Geographical Information Systems as a common technical term in the 1980s, and there has been a rapid rise in the theoretical, technological and organisational development of GIS. As a result, the field is now characterised by a wide diversity of applications, many of which draw on ideas from different disciplines. Given this diversity, it follows that a variety of different definitions of GIS have been proffered, and this variety often depends on who is offering the definition, and their background and perspective (Pickles, 1995). Given the many attempts to define GIS, it is difficult to arrive at a just one definition, especially since definitions are likely to change over time with developments in technology and applications. The common thread through all definitions is spatial data processing for the management of information about a particular environment, and in general, definitions tend to cover three main elements: a computerised system; spatially referenced or geographical data; and data management and analyses. GIS should not be confused with computer assisted cartography or computer aided design (CAD) which essentially focus on graphic drawing and do not have GIS data management and analyses functions (Bromley and Coulson, 1989). Some selected definitions of GIS are illustrated in Table 4.1.

Table 4.1 – Examples of GIS definitions

GIS Definitions	
DoE (1987, p.132)	A system for capturing, storing, checking, manipulating, analysing and displaying data which are spatially referenced to the Earth
Aronoff (1989, p39)	Any manual or computer based set of procedures used to store and manipulate geographically referenced data.
Burrough (1986, p6)	A powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world.
Jankowski and Nyerges (2001, p4)	An information technology that can facilitate a computer-supported approach to spatial decision making
Cowen (1988, p1554)	A decision support system involving the integration of spatially referenced data in a problem solving environment.

At the simplest level, GIS may be regarded as a computer software package, the components being the various tools required to enter, analyse and output data. In a wider context GIS comprise computer hardware, computer software, spatial and attribute data, data management and analyses, and trained personal responsible for designing, implementing and utilising GIS (Maguire, 1991).

4.2.2 Computer hardware and software

The hardware element of GIS can run on almost any type of computer platform, ranging from dedicated, high specification mainframe computers with built in digitizers and scanners, to relatively low specification personal computers. In the early 1990s most GIS were run on Unix operating systems, but with the development and dominance of Microsoft, most are now run on Windows operating systems.

As GIS developed, three basic designs emerged that differed in the type of database model used; hierarchical, network and relational. At present the relational database model dominates GIS (Heywood *et al*, 2002), which may be partly due to its greater flexibility compared with hierarchical and network models. In relational databases, data are organised in a series of two-dimensional tables, each of which contains a record for one entity. These tables are linked by keys, and queries can be run on individual tables or groups of tables using standard query language (SQL). This facilitates a range of queries from the most basic to complicated multi-component queries, and in principal there are very few restrictions on the type of queries that GIS can handle. The range of functions offered by GIS will depend on the type of software. Longley *et al* (2001) have summarised the large range of software packages into six different groups which have been adapted by Heywood *et al* (2002) and are detailed in Table 4.2.

Table 4.2 – GIS software types (adapted from Heywood *et al*, 2002)

GIS Software Types	
Professional	High-end GIS products that offer the full range of modelling and analysis functions. The two most frequently used packages in the UK are ArcView and MapInfo, which offer similar functions but have slightly different interfaces. These are the most expensive packages. They can run on PCs.
Desktop	Desktop mapping systems have become popular GIS systems. They do not offer the full range of analysis of data input functions, but are easy to use and geared more towards data display than analysis. These are less expensive than professional packages. An example of desktop software is MapPoint from Microsoft.
Hand-held	Hand-held hardware and GIS software specifically designed for fieldwork are recent developments, incorporating global positioning systems (GPS) and primarily used for data capture and navigation. Many of these are designed to work together with internet based products, and they provide a more limited range of functions.
Component	Tool kits of functions / components can be used to specialised systems that only require a subset of the full range of functions. These systems are often embedded within other packages so that end users may be unaware that GIS has been employed.
GIS Viewers	These allow the display of files in common formats, and may allow simple queries and mapping, but not modelling and analysis functions.
Internet GIS	These offer very limited functions, and are likely to have been designed for specific purposes, such as online location finding or route planning.

4.2.3 Spatial and attribute data

Geographical entities are elements of a real world system contained in a geographical space. An object is a GIS representation of a geographical entity, e.g. roads, towns, forests are represented in the form of point, line and area (polygon) objects. The objects are described by locational or spatial data, which records the location of a given object, and attribute data, which describes characteristics of the object (Malczewski, 1999). Each spatial entity, whether a point, line or area, may have one or more attributes associated with it. For example, a point representing a materials recycling facility (MRF) can be linked with a number of characteristics, such as material type and tonnages, rejects, reprocessing details, name and address of owner.

Points are used to represent features that are too small to be represented as an area, such as a small bring site for recyclables. A spatial reference is used to locate the point, together with attribute details explaining characteristics such as the location of a bring site facility and the types of recyclables accepted. Lines are used to represent features that are linear in nature, such as roads and rivers. They can also be used to represent non-physical features such as administrative boundaries. A line is represented by a string of co-ordinates joined together by straight lines. The accuracy of the representation will depend on co-ordinate frequency. Lines are frequently connected together to form networks, such as roads, which could then be used for route planning. Areas (polygons) are represented by a closed set of lines used to define features such as fields, buildings, or administrative areas. Adjacent polygons share boundaries between adjacent areas, such as postcodes and property boundaries.

Map projections are used to transfer the spherical earth into two dimensions, and spatial referencing is then used to locate the spatial entities within these two dimensions. There are several different types of map projections, all of which will lead to some distortion in transferring to two dimensions. Different projections are suitable for different purposes in order to limit distortions (for further explanations of map projections see Seegar, 1999; Monmonier, 1991). Spatial referencing can be grouped into three categories:

- geographic co-ordinate systems;
- rectangular co-ordinate systems; and
- non co-ordinate systems.

Geographic co-ordinate systems are based on longitude and latitude, which can be used to locate all the features on the Earth's surface in relation to one another and the distance between them. The longitude and latitude referencing system is suitable for small-scale maps (i.e. which cover large areas), but as it assumes the Earth is a perfect sphere it will lead to distortions on large-scale maps (i.e. focusing on a small surface area), and local corrections are essential to account for these distortions (Heywood *et al*, 2002).

Rectangular co-ordinate systems are designed to map specific geographical regions. Each rectangle covers a specific region, but as part of a large co-ordinate system it can relate to a large surface area. As an alternative to the geographic co-ordinate system, rectangular co-ordinates minimise distortions. The Ordnance Survey National Grid is a rectangular based system, which divides the UK into 100 km squares which are identified by two letters. These squares are then subdivided, and grid references are given as six figures denoting this subdivision, prefixed by the letters denoting the 100 km square. The first three of the six figures are commonly referred to as the 'easting' and the second three the 'northing' (see Heywood *et al*, 2002).

Non co-ordinate systems provide spatial references using a descriptive rather than co-ordinate references. The most widely used non co-ordinate system in the UK is postal codes. Designed by the Royal Mail to improve postal efficiency, the post code system can be used in GIS to locate and map addresses. It is based on a hierarchy that identifies area, district, sector and unit, and is illustrated in Figure 4.1.

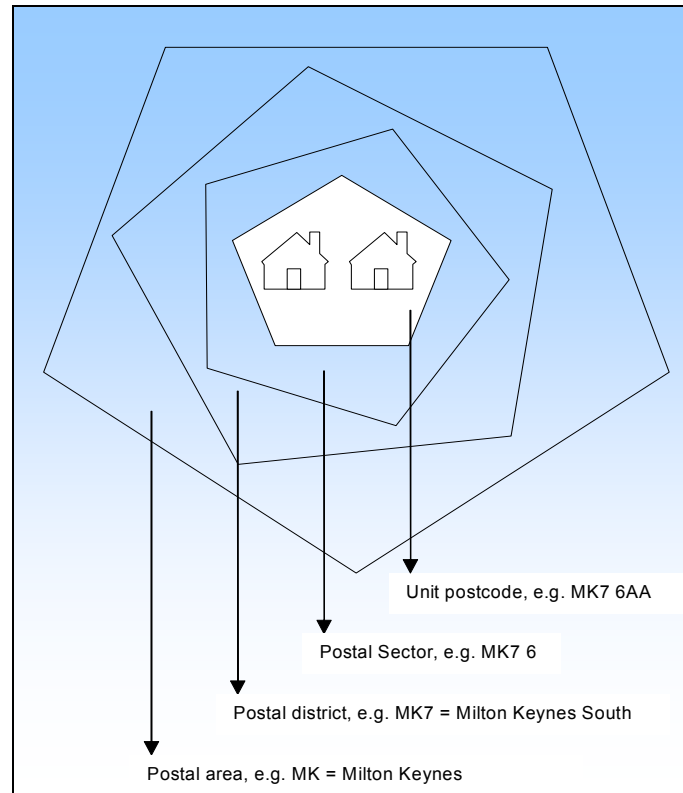


Figure 4.1 - The UK Postcode System (adapted from Heywood *et al*, 2002)

Given the different spatial referencing data systems, it will frequently be necessary to integrate data collected using different systems (Heywood *et al*, 2002; Malczewski, 1999). For example, GIS using Ordnance Survey (OS) digitised maps use data recognised by the rectangular co-ordinate system, requiring translation of geographic co-ordinates and postcodes into rectangular co-ordinates. As GIS has developed so have links that allow integration and conversion of data, so that integration of data between the main spatial referencing systems is now relatively straightforward.

4.2.4 Sources of data and data input

GIS are unique in their capacity for combining and analysing multi-source data, such as data on public infrastructure, population, transportation networks, topography and climate. Professional GIS software typically allow a variety of methods for data input, including keyboard entries for spatial and non-spatial attributes, manual locating devices (such as global positioning systems, digitizers), scanning, and importation of existing data files.

4.2.4.a Digitised maps

Digitising maps involves encoding analogue data into digital data. The Ordnance Survey provides the most comprehensive digitised map available for the UK. OS began to digitise its maps in the mid 1970s, primarily to improve the efficiency of cartography. This data was restructured in the 1980s to extend the use of digitised maps beyond cartography, such as GIS (Bromley & Coulson 1989). OS now have a range of digitised maps for use with GIS, and information on these together with free demonstrations are available from their website www.ordsvy.gov.uk. One of the OS's most comprehensive digitised datasets is Land-Line which depicts man-made and natural features ranging from factories, roads, rivers and administrative boundaries, and these are available in different scales according to location:

- 1:1250 scale in urban areas;
- 1:2500 scale in rural areas; and
- 1:10,000 scale for remote area such as mountains / moorland.

In addition to Land-Line, OS have recently launched OS Master-Map, a dataset as comprehensive as Land-Line but designed for greater flexibility and accessibility, allowing the user to select the precise mapping data required, which can then be used in association with third party information and data. This will facilitate data flows and knowledge sharing between different areas and organisations. Most local authorities already use OS Land-Line data for infrastructure planning and some service delivery, such as transportation and healthcare.

Licence agreements for OS digitised map use and maintenance are expensive, although discounts are possible through partnership agreements. Less expensive alternatives to OS digitised maps are available. For example, Bartholomew (part of the Collins Information Business that produce Collins maps and atlases) datasets are incorporated into many GIS data products and Internet mapping services. They have a range of digitised products available on their website www.bartholomewmaps.com, which start from a large-scale ratio of 1:10,000 which, whilst detailed enough for many purposes, are not as detailed as the 1:1,250 Land-Line data available from OS. An example of the difference in level of detail between these two scales, is that post-code data can be mapped onto the OS land-Line map at the unit postcode level (see Figure 4.1), whereas the Bartholomew maps are limited to postal sector.

Although OS and Bartholomew are the leaders in the field of supplying digitised maps for the UK, there are a number of other sources that can be accessed from the web addresses listed in Annex 1. If less detailed maps are required than those supplied by OS and Bartholomew, it is

possible to digitise paper (analogue) maps or aerial photographs using manual digitising or scanning equipment (for further explanation see Heywood *et al*, 2002; Malczewski, 1999).

4.2.4.b Global positioning systems

Global positioning systems (GPS) are an important source for gathering raw data in the field for direct input into GIS, especially where spatial referencing is not available in other formats such as maps or satellite images (Heywood *et al*, 2002). GPS receivers are hand-held devices that use signals from a set of GPS satellites to work out the exact location of the user on the Earth's surface in terms of geographic co-ordinates. GPS receivers are widely available, and although sophisticated versions are accurate up to a distance of 0.5m, most standard versions are now accurate up to around 3m. Some GPS are compatible with professional GIS software packages, enabling co-ordinates to be downloaded directly into GIS, whilst other GPS data may require translating before GIS input.

4.2.5 Data structure and analysis

There are a number of different data structures in use in GIS, which can be categorised according to whether they are used to structure raster or vector data. Data in raster format are stored in cells (pixels). Points are represented by single cells, lines by connected cells, and areas by contiguous cells. The maximum resolution of raster maps will be determined by individual cell size. Raster structures are suitable for representing data that vary continuously, such as temperature, and is typically the format used by satellite imagery (Malczewski, 1999). Raster structures are also suited for digitising analogue maps, aerial photographs or drawings (Bromley and Coulson, 1989). Data in vector format are entities provided by strings of co-ordinates that represent their exact geographic location, thus vector uses a point format compared to the raster cell format. Each of the spatial objects in a vector structure may have an identifier that is a key to a related database containing the attributes of the entity. Using a point rather than a cell format leads to greater precision, hence a disadvantage of raster structures are inaccuracies in precise positioning. Raster and vector structures are suitable for different applications. Raster structures are more suited to analysis related to areas (i.e. the contents of areas are more important than the boundaries between them), and their ability to handle continuous data means they are well suited to environmental applications such as flood or climate change modelling (Malczewski, 1999). Vector structures are boundary orientated (importance of spatial object boundaries is emphasised) which makes them well suited to sophisticated data base queries, measurements and network analysis, and they are more appropriate than raster structures for socio-economic applications (Malczewski, 1999). It is important to note that any real-world situation can be represented in both raster and vector structures, and increasingly software packages allow data modelled in one structure to be transformed into the other, and some systems allow raster data to be overlaid onto vector data, and vice versa.

Data in most GIS are organised by separate thematic maps known as a map or data layer. A map layer is a set of data describing a single characteristic of each location within a bounded geographical area. For example, there may be separate layers for soil cover, surface waters, road networks, waste and recycling facilities and demographics, as illustrated in Figure 4.2. A map layer can be displayed, manipulated, and analysed individually or in combination with other map layers.

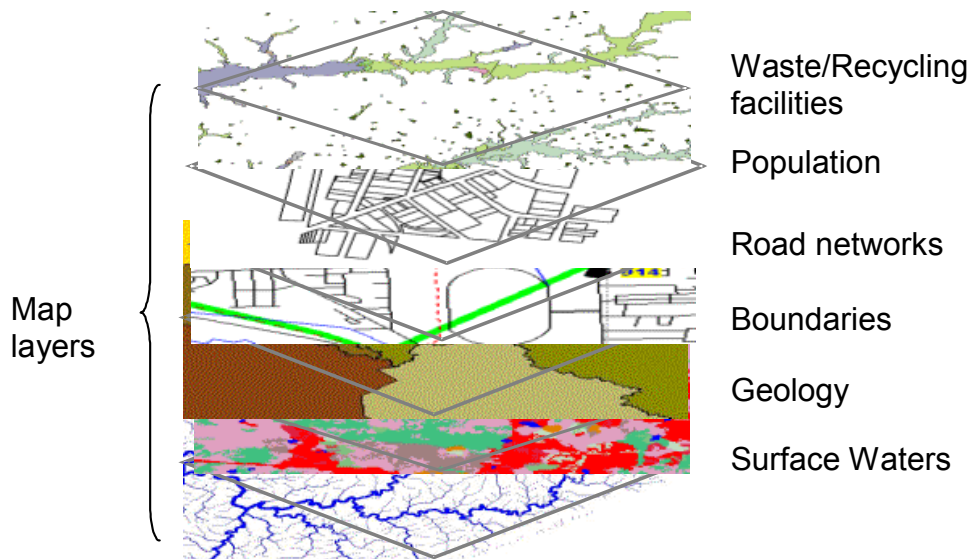


Figure 4.2 - Example of GIS map layers

There are a range of data analysis functions available in GIS, which can be illustrated by categories of basic questions (adapted from Rhind, 1990):

- location what is at...?
- condition where is it...?
- trend what has changed...?
- routing which is the best way...?
- pattern what is the pattern...?
- modelling what if...?

The location type question involves querying a database to determine the type of features that occur at a given place, e.g. what is the population in a given area. The condition question is really the converse, and is concerned with finding the location of sites that have certain characteristics, e.g. areas of land in excess of 500m from housing but within 100m of major roads. The trend question involves monitoring how things have changed over time, e.g. road usage, rainfall and flooding. The routing question requires calculation of the 'best' route between places, e.g. in terms of the fastest or the shortest. The patterns question enables description and comparison of phenomena, to facilitate investigation between factors and potential processes accounting for their distribution, e.g. patterns in the distribution of illnesses thought to be linked to pollution, and the modelling question allows different scenarios to be evaluated (Maguire, 1991).

These questions can be investigated through a number of functions:

- measurements – lengths, perimeters and areas;
- queries;
- network analysis;
- buffering;
- map overlay.

The measurement functions enable calculations associated with points, lines, areas and volumes. For instance, it can be used to calculate distances between points, e.g. the distance a refuse collection vehicle would need to travel to the nearest waste or recycling facility, or to

identify the number of points within a given area. The measurement function could also be used to calculate areas such as garden size, which could then be used to target suitable households for kerbside collections of garden waste.

Spatial and aspatial queries can be performed with most GIS (Heywood *et al*, 2002). Aspatial queries relate to attributes of features. 'How many bring sites accept garden waste?' is an example of an aspatial query. 'Where are the bring sites that accept garden waste?' is a spatial query that involves identifying how many and their spatial location, and this could be produced in tabular or map form. Standard query language (SQL) and Boolean operators can be used to create individual queries to identify entities that satisfy a number of spatial and aspatial criteria.

Networks are groups of interconnected lines that make up a feature, for example, roads, pipelines or cabling network. In terms of roads, network analysis can be used to address a number of related themes. The shortest or fastest route between two points is widely used for electronic based individual journey planners. Extending this theme, route planning can be used to identify efficient multi-point routes, for example refuse collection rounds (see Insert 4.1). Network analysis can also be used to model supply and demand through a network, and supply and demand values can also be used to determine maximum catchment areas for a given supply (or service) centre.

Buffering is the creation of a zone of interest around an entity, within which a number of queries could then be applied. For example, a buffer could be created around main roads, either based on distances or travel times. A query could then determine the number and location of bring sites within the buffer, and to determine the types of waste accepted at the different sites. Another use could be to create a buffer around an existing or proposed bring site, and then calculate the number of households within a certain distance of each site, based on distances householders would be prepared to travel to use the site. An example of buffering is illustrated in Figure 4.11).

Map overlay is a key GIS function, and involves layering a number of thematic maps of the same area to create a new layer. A common application is to use queries to establish features on one layer, and then to overlay this onto another layer, this can then be repeated for various layers to satisfy a number of criteria. This approach is typically used for site selection or suitability analysis (Heywood *et al*, 2002), and Figure 4.3 illustrates an example overlay process to identify suitable areas for a landfill.

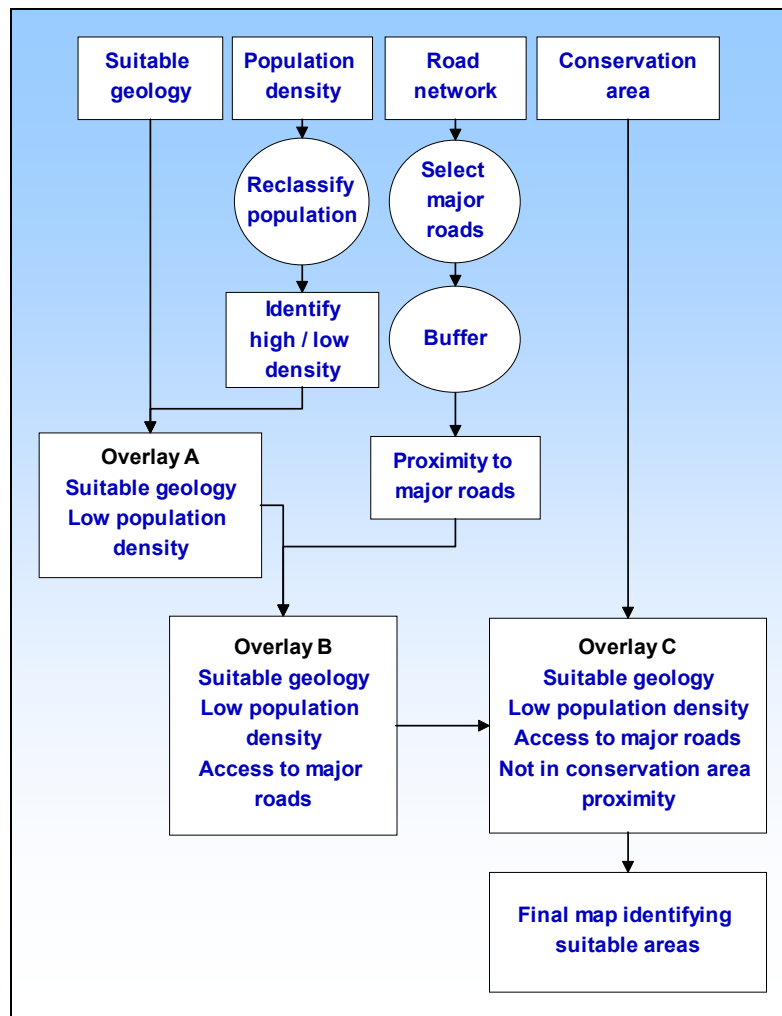


Figure 4.3 - An example of overlay function to identify suitable sites for a landfill (from Heywood *et al*, 2002)

4.2.6 GIS applications

The GIS market has grown to accommodate general purpose and tailored software packages for a wide range of applications (Heywood *et al*, 2002). GIS could be beneficial in many areas of the public and private sector, especially where decisions about location are important, and where spatial data are linked to different attributes. Table 4.3 shows a selection of GIS applications from different sectors.

Table 4.3 - Example of GIS application areas (adapted from Heywood *et al*, 2002)

Government	Environmental Management	Commerce and business	Utilities
Health	Landfill siting	Market share analysis	Network management
Local govt.	Mineral mapping	Insurance	Service provision
Transport planning	Pollution monitoring	Fleet management	Telecommunications
Service planning	Resource management	Direct marketing	Emergency repairs
Urban management	Environmental impact assessment	Retail site location	

The range of GIS applications can be grouped into three categories: operational; management / tactical; and strategic (Heywood *et al*, 2002; Serwan *et al*, 1998). Operational applications are characterised by the collection and storage of data used for the management of facilities and assets. Management applications are concerned with distributing resources for efficient and effective service delivery, or to gain competitive advantage and strategic applications are concerned with developing longer-term strategic plans. Ideally, GIS design and use will integrate these categories, so that operational and management applications help deliver strategic plans, and strategic development is informed by experience and outcomes from operational and management applications.

The nature of GIS means that analyses on a number of interacting activities and services can be conducted for a particular area. In relation to public service provision, research in the UK has focused mainly on health and transport. Lovatt *et al* (2001, 1998) used GIS to assess health needs, and incorporated travel times and public transport services to investigate the accessibility to primary healthcare services, and to assess the consequences of accessibility in relation to proposed cuts to bus services. On a similar theme White (2001) outlines a study to assess accessibility to GP surgeries in rural areas, and Kelly *et al* (2001) use travel times to measure accessibility of public services for rural populations, and proposes travel time as an alternative to population sparsity measures for allocating service funding. Mitchell *et al* (2000) used GIS to model population and mortality to investigate health inequalities, and to develop scenarios investigating the effects on patterns of mortality of child poverty eradication and full employment. Titheridge (2001) has developed a model aimed at assisting local authorities in planning new housing developments in parallel with traffic demand reduction strategies.

4.2.7 Development and use of GIS in central and local government

In general the development and uptake of GIS in the UK has been slower than in some other countries, particularly the USA (Heywood *et al*, 2002). It has been suggested that this may be due to a number of reasons, including availability of large-scale printed maps, backlog of analogue data, centralised government decision making, and a lack of the awareness of the benefits of GIS (Rhind and Mounsey, 1989; Rhind, 1987). In an attempt to address these issues, recommendations for increasing awareness and promoting GIS were published by the Committee of Inquiry into the handling of geographic information, commonly referred to as the Chorley Report (DoE, 1987). Following on from these recommendations, the Association for Geographic Information (AGI) was launched in 1989. Dedicated to the advancement of the use of geographically related information, AGI has members drawn from most sectors of government, business and academia. AGI recognised the need for more co-ordination between government departments, and in 1993 the Inter-departmental Group on Geographic Information (IGGI) was established. IGGI provides a forum for government departments and agencies to develop and facilitate the effective use of geographic information.

Initiatives by AGI and IGGI have increased accessibility of OS maps for central and local government. OS data underpins a wide range of public service provision, including crime prevention, emergency services, transport planning and land management. Through agreements developed between local authorities and OS, every local authority in the UK has access to OS data. As part of a more recent initiative between DTLR and OS, this data is now available to central government departments and agencies. The aim is for all government departments to make use of OS data, into which they can input their own relevant datasets to inform decision making and service provision. According to the Planning Minister, access to OS data “can really make a difference to the way the government is able to plan for better public services” (Keeble, 2002). In addition, AGI and IGGI have helped develop the Geographic Information Gateway (Gigateway), which provides information on accessing over 600 geographically referenced datasets held by government departments and agencies.

In light of these initiatives, GIS is becoming increasingly common within central and local government (Harrison and Haklay, 2002). Examples include:

HM Land Registry

Computerised mapping through GIS has now been implemented across all land registry offices in England and Wales, and it is envisaged that the Land Registry e-conveyancing initiative will dramatically shorten conveyancing processes.

The Environment Agency

The Environment Agency are developing flood models using their own data and integrating this into a GIS using data from a range of other sources including OS, the Institute of Hydrology and British Geological Survey. These models are playing an increasingly pivotal role in providing earlier flood warnings. In addition to flood models, GIS are also being developed for water resources and ground water protection through river catchment modelling.

Department of the Environment Food and Rural Affairs

Following the outbreak of foot and mouth disease in 2001, DEFRA are developing GIS to integrate data and create maps showing information such as livestock movements and holdings, together with patterns of livestock disease. Using GIS is seen as critical in providing the flexibility to update, analyse and produce current information in a rapidly changing situation, together with the immediate electronic distribution of this information throughout the country. In addition to monitoring livestock disease, GIS is used throughout DEFRA to aid emergency management planning.

Southampton Council

Southampton has developed a GIS system that uses OS digital mapping in conjunction with automatic vehicle location systems and route tracking to help constantly monitor and report on traffic flows. Up-to-the minute information allows travellers to plan their journeys avoiding road-works and long delays, and can even receive information and availability of parking spaces. Following the success of the system in Southampton, it is being extended to Winchester and other parts of Hampshire.

4.3 GIS for Informing and Delivering Waste Management Strategies

Although GIS is increasingly used in central and local government, it has primarily focused on land-use planning (Harrison and Haklay, 2002), together with health and transport provision. According to Maguire (1991) applications have been dominated by illustrative mapping, inventory and information management, and the full potential of GIS in terms of analysis and decision support has not yet been realised. However, to-date GIS has been rarely used in developing and delivering waste management and recycling strategies, either in terms of inventory, management or analysis. This section highlights a few examples where GIS has been used, and considers potential future applications and illustrates hypothetical examples.

4.3.1 Site selection and planning

The most common use of GIS in relation to managing waste is for site selection. There are a number of examples in the UK and overseas of GIS application for locating suitable landfill sites (Heywood *et al*, 2002; Siderelis, 1991; Openshaw, 1989). An example of the processes employed in site selection is summarised in Figure 4.4. The first step involves identifying siting factors, which are likely to include geology, transport networks, nature conservation area and demographics. Each of these factors needs to be represented as a separate data layer in GIS, which may involve having to digitise analogue data if digital data is not readily available. These data layers can then be refined so that they represent specific siting criteria. For example,

the geology layer may be refined so that it only highlights areas with suitable geology, and the transport network layer network may be refined so that it identifies areas close to major routes. After each layer has been refined to match siting criterion, the layers can then be combined to provide a base map, which can then be refined using additional siting criteria if required. The advantage of using GIS for this process is the flexibility it provides in allowing for changes in siting criteria. Once potential sites have been identified, GIS can then be used to help comparative evaluation between sites.

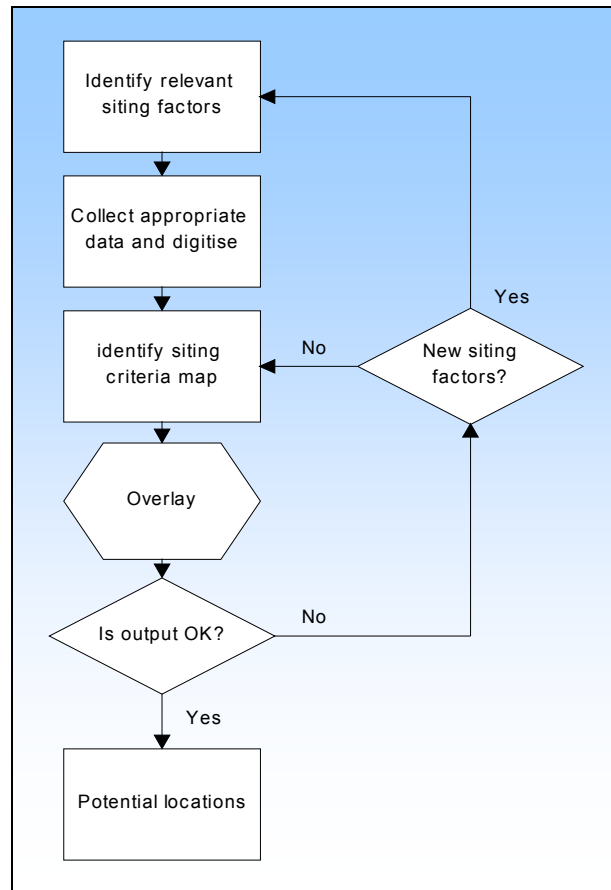


Figure 4.4 - Using GIS to identify potential landfill site locations (adapted from Heyood *et al*, 2002)

The processes illustrated in Figure 4.4 were used by NIREX for identifying potential radioactive waste sites, and results from different siting scenarios are illustrated in Figure 4.5

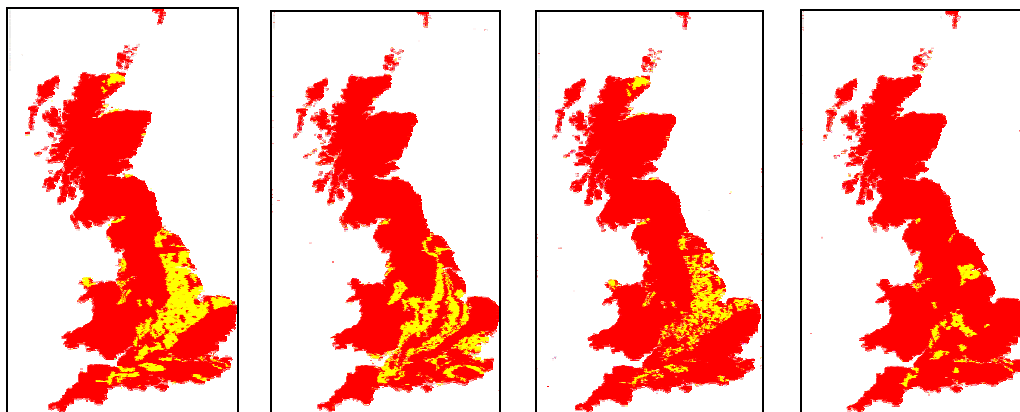


Figure 4.5 - Potential hazardous waste sites: results from different siting scenarios (Heywood *et al*, 2002); Red (dark) = unsuitable; Yellow (light) = suitable

In contrast to the national example in Figure 4.5, GIS can also be used to locate suitable sites on a local scale. Valeo *et al* (1998) used GIS to identify the number and location of bring sites required under different scenarios for a town in Canada. Unlike the layering approach to identify a location with multiple specifications, Valeo *et al* used accessibility criteria to develop two scenarios. The first was based on a high density of sites that householders could walk to, and the second based on a lower density of sites using travel times. On a similar theme, Parfitt *et al* (2002) used travel times to estimate accessibility to existing civic amenity sites in South Norfolk, which highlighted areas furthest from the sites in terms of minutes travelled and thus potential locations for additional sites. The output from this travel time analysis is illustrated in Figure 4.6

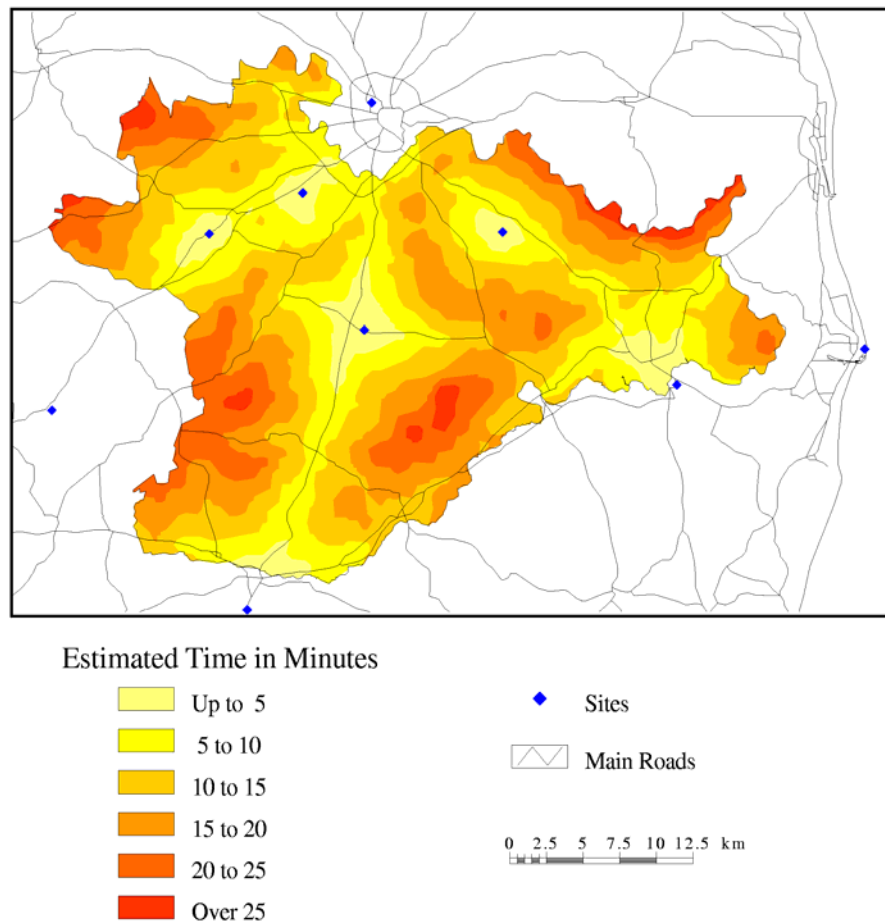


Figure 4.6 – Estimated car travel time to nearest CA site in South Norfolk (Parfitt *et al*, 2002)

4.3.2 Monitoring and emissions modelling

GIS can be used for a range of waste monitoring purposes. In respect of an individual landfill site, GIS can be used to outline the void space, to calculate lining requirements, to calculate volumes of individual cells, and identify appropriate leachate and gas monitoring locations. For post closure purposes, GIS can be used to record leachate and methane levels, as well as predicting settlement patterns.

GIS allow spatial patterns of pollutants to be modelled, and data on pollutant concentrations and population distribution to be combined and analysed. Studies have been conducted into the health risks associated with living close to landfill sites (Briggs *et al*, 2001; Fielder *et al*, 2000), and the Environment Agency are developing a National Landfill GIS. Although most available examples relate to landfill, GIS can be used to monitor and model pollutant and particulate

matter from any waste or recycling plant, such as emissions from Energy from Waste plants, and bioaerosols from composting plants.

4.3.3 *GIS and waste collection and transport*

GIS has a number of potential applications in relation to waste collection and transport. As with all applications, these are applicable at various scales, from the national, to the regional and local.

On a national scale, the Scottish and Northern Ireland Forum for Environmental Research (SNIFFER) are using GIS assessments to develop a tool to assist the planning of waste and recycling facilities. The project takes an integrated approach to the transport of waste, so that the optimum mode for a given journey may be determined by factors such as cost, waste characteristics, energy consumption, travel time, travel distance, congestion or environmental performance. The main purpose of the project is to provide a tool for the planning system to ensure that waste management facilities can be located to minimise journey distances and emissions (SNIFFER, 2001).

At a more specific level, GIS is a valuable tool for route planning, and can be used to improve waste and recycling collection efficiency. It can be used to plan routes that need to avoid particular areas, or certain times of day, and can be used to schedule the most efficient routes to maximise household collections. Whilst there are examples of collection route planning in North America and Europe, GIS has largely been overlooked by commercial waste management companies in the UK (Whittle, 2002), and there is little evidence to suggest that it is used by unitary or waste collection authorities. However, Ealing Community Transport (ECT) has used GIS since 1995, and their experience is illustrated in Insert 4.1.

Insert 4.1- Ealing Community Transport

Using GIS to predict recycling behaviour and route plan

Ealing Community Transport was set up in 1979 as part of the Council for Voluntary Service in Ealing, and is an independent charitable not-for-profit organisation established for the benefit of the community. Originally, ECT focused on the provision of community transport, and then vehicle maintenance service. In the mid 1980s ECT became involved in a number of re-use and recycling activities, and in 1994 ECT Recycling was set up as part of the larger ECT group. Following a pilot kerbside recycling service, ECT Recycling was awarded its first borough wide contract to collect recyclables in Hounslow, in partnership with Hounslow Environment Services Direct, the local DSO. Since this first contract, ECT Recycling has gone from strength to strength. Lambeth Community Recycling was established as a subsidiary of ECT Recycling, and overall they operate bring and kerbside systems in 10 London boroughs, and are contracted to supply recycling services to over 800,000 households. ECT Recycling also operates outside London, with recycling service provision in Oxfordshire, including the Vale of White Horse, West Oxfordshire, and most recently Warwick.

GIS has been an important tool for ECT Recycling in compiling tenders and securing contracts. ECT's GIS system is based on correlating compositional data with ACORN classifications and incorporating these into a postcode and street level based GIS. ACORN (A Classification of Residential Neighbourhoods) is a system of socio-demographic profiling. ECT compositional data set has been built up through extensive collection trials. These trials are designed to be representative of the demographics in an area, and the results are input into the GIS by ACORN group. Unlike some ACORN based compositional analysis based on larger aggregates of ACORN groups, ECT use a very detailed 55 type classification systems, which gives a more accurate representation and avoids the problem of masking variations which can arise from aggregating groups.

Accurate and representative empirical data allows ECT to estimate quantities and compositions of recyclables that are likely to be collected from a household for each classification type, which can then be aggregated to give estimates for a whole area. ECT acknowledges that ACORN groups are not sufficient for predicting recycling behaviour, as behaviour will be influenced by a myriad of other factors. One important factor is collection infrastructure, and ECT can take account of this by cross-referencing ACORN group with collection factors such as whether or not householders are supplied with wheeled bins, and collection frequency. Other factors may be more difficult to account for, and require a detailed understanding of the nature of the target area. For example, areas where recycling schemes are already established may yield higher quantities than areas not familiar with schemes. In addition, ECT has found that the popularity of a local council will impact upon how householders respond to recycling initiatives (Whittle, 2002). Thus, more qualitative factors need to be taken into account alongside GIS output in modelling predictions. ECT then use the predictions for tenders and planning contracts. Estimates of quantities and composition of recyclables are used to calculate vehicle requirements, and in contracts secured to-date, ECT have "never got truck provision wrong for weekly multi-material kerbside operations" (Bond, 2003).

Insert 4.1 - Continued

In calculating vehicle provision, ECT also use GIS for route planning. They have found that basing route scheduling on time is more effective than routing based on number of collections. GIS travel time combined with calculations for time per household collection are used to plan routes around the capacity of the vehicle, and an example of planned route output is illustrated in Figure 4.7. The collection routes have been linked with ECT's website, so that householders are able to check their scheduled collection day.

In addition to predicting recycling activity and route planning, ECT has also used GIS to help determine appropriate trial areas. For example, in planning kerbside collection trials for garden waste, ECT used polygon analysis on OS Landline data to determine the number and size of gardens to be included in the trial. ECT is developing their GIS with the aim of integrating the whole collection system, so that quantities collected are logged against predictions, and householder complaints and queries can be incorporated with collection data.



Figure 4.7 - Collection route planning using GIS

4.3.4 GIS and public participation

A frequent criticism levelled at GIS is that it is an elitist technology, accessible only to those with sufficient technical know how and financial resources (Heywood *et al*, 2002; Cinderby, 1999). New participatory approaches to GIS are emerging which address these criticisms. Public participation geographic information systems (PPGIS) have all the capabilities of GIS, with additional capabilities for group decision support (Jankowski and Nyerges, 2001). PPGIS involves the integration of conventional spatial data with mental maps, showing communities (or different groups) perceptions of their environment and how they use resources. The potential to combine different perceptions allows for the investigation of multiple realities, which can help promote policy development by raising potential conflict issues which may need to be addressed, as well as highlighting similarities and consensus. Thus decision-makers

are able to make decisions that are more in tune with local feelings and needs (Heywood *et al*, 2002).

Early PPGIS approaches explored problems with the aid of relevant GIS data sets, which required participants to work around a single work station. Increasingly PPGIS use Internet based approaches, which offer greater accessibility by removing time and location restraints, but obviously require participants to have Internet access. This may develop in the context of physical or land-use planning in the UK, as central government expects all local authorities to provide internet based planning services by 2005 (DETR, 2001), and GIS is likely to be an important part of these services (Harrison and Haklay, 2002). PPGIS is a relatively new application, and given the limited use of GIS to waste management generally, it follows that PPGIS has had limited use in context of waste strategy and planning. However, the ability of PPGIS to accommodate a large number of opinions, and to integrate different perspectives with spatial data, means that it could have an important future role in raising awareness and helping resolve conflict. This may be particularly relevant for planning and siting waste facilities, often the subject of public resistance.

4.3.5 GIS and recycling: targeting specific areas or specific materials

GIS provides a powerful tool for communicating a large amount of data at a glance. Over the last few years DEFRA have included GIS produced maps for illustrating their household municipal waste statistics. Figure 4.8 shows national recycling rates in England and Wales (DETR, 2000), and has been included to illustrate how such images can be used to easily identify high achievers as well as areas that need to be targeted to improve recycling performance.

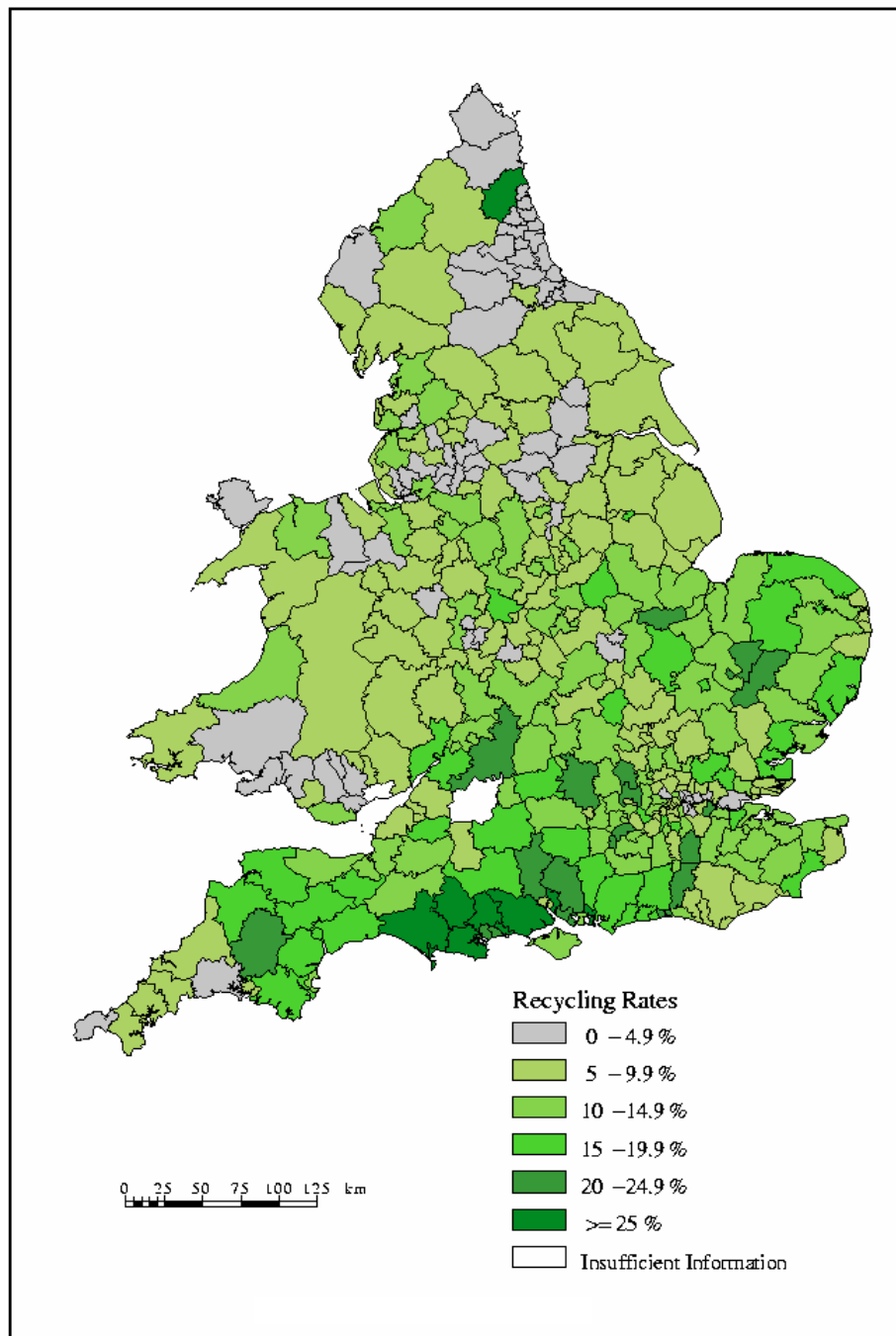


Figure 4.8 - Household waste recycling 1997/98 (DETR, 2000)

Figures 4.9 to 4.11 give an illustrative example to show how similar representations can also be produced for an individual authority, and how this can aid decisions about recycling initiatives. Figure 4.9 illustrates responses to a questionnaire on householders recycling behaviour in the Royal Borough of Kensington and Chelsea categorised by non, low, moderate and high recyclers.

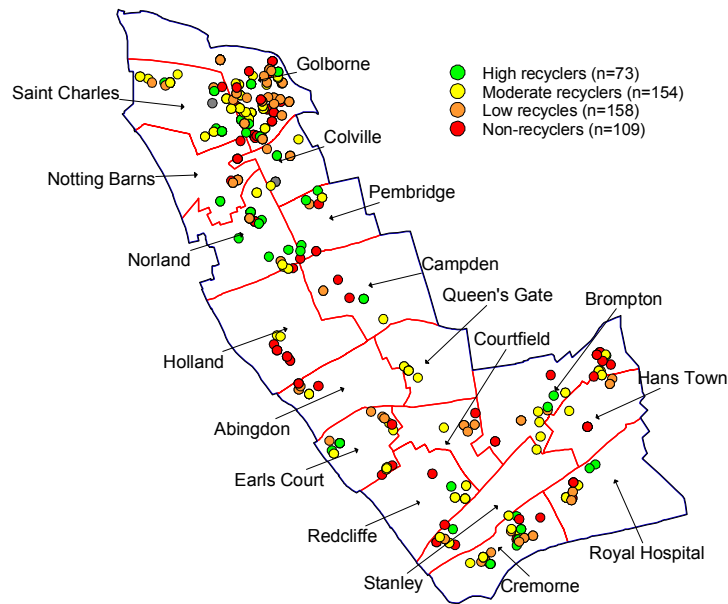


Figure 4.9 - Household recycling behaviour in the Royal Borough of Kensington and Chelsea (© Crown Copyright All Rights Reserved. Royal Borough of Kensington and Chelsea License No. 086460 – 2003) (Thomas *et al*, 2003)

If it is assumed that respondents in Figure 4.9 are representative of recycling behaviour for each ward within the borough, the responses can be aggregated and illustrated as a relative average for each ward, which is shown in Figure 4.10.

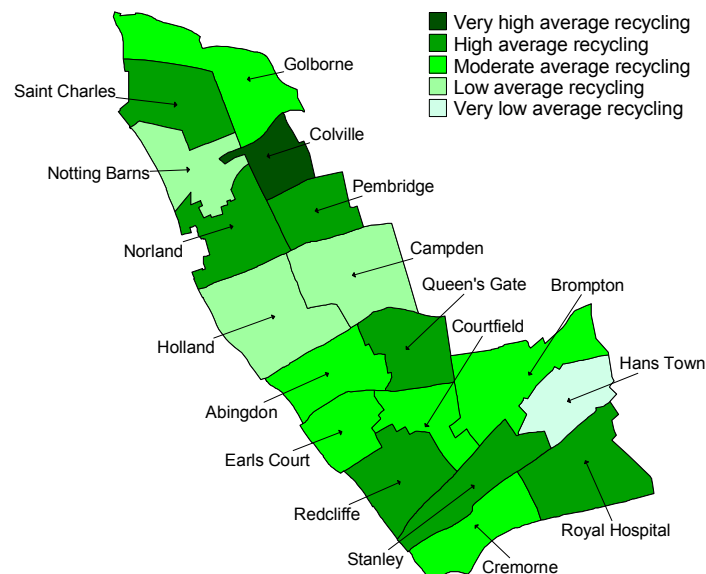


Figure 4.10 – Average recycling behaviour for each ward in the Royal Borough of Kensington and Chelsea (© Crown Copyright All Rights Reserved. Royal Borough of Kensington and Chelsea License No. 086460 – 2003) (Thomas *et al*, 2003)

Illustrating average recycling behaviour by ward means that performance in each ward can be easily identified, and could be used by authorities as part of their decision process for targeting recycling initiatives. Further information could be included in the GIS to aid this decision process. For example, bring sites and CA sites could be mapped so determine whether there is any correlation between recycling behaviour and access to recycling facilities. Such a correlation may show, for example, that the Hans Town ward (with the lowest recycling

average in Figure 4.10) has relatively fewer recycling facilities compared with other wards, and one recycling initiative could be to introduce additional bring sites. GIS could then be used to determine suitable locations for additional sites.

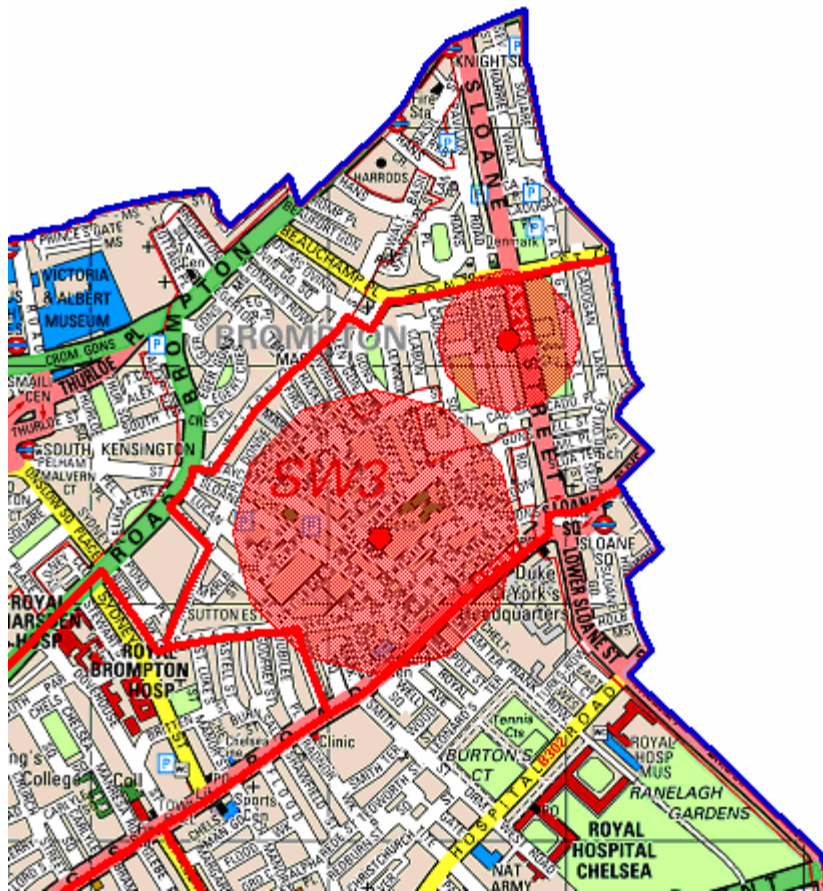


Figure 4.11 - Buffer zones around additional bring sites in the Hans Town ward (© Crown Copyright All Rights Reserved. Royal Borough of Kensington and Chelsea License No. 086460 – 2003) (Thomas *et al*, 2003)

Figure 4.11 shows how buffer zones can be used to identify potential users of additional bring sites. Two potential sites are illustrated, and both assume that use will be affected by distance from the householder. The smaller buffer shows a potential location with a 150 metre distance zone, the larger zone represents 300 metres. It is then possible to calculate the number of householders captured within these zones, which can be used to help determine locations that will be accessible to the greatest number of households. Information on households targeted could then be used for other purposes, such as identifying the target area for a promotional campaign.

As well as the borough and ward level, GIS can be used at a sub-ward or sub-district. Parfitt *et al* (2002) reconstructed the household waste stream at a sub-district level in South Norfolk using GIS to integrate bring site data, kerbside collection data and population characteristics. This involved collecting and recording waste collection and recycling data at the level of individual refuse collection rounds across an authority. Catchment areas around bring and CA sites were established based on travel times, and bring site weight data was then assigned to the individual rounds within the catchment area. The result was a database detailing total waste and recyclables for each collection round. Understanding waste flows at this level of detail is important for underpinning waste strategy development at the local level, as it provides a

framework in which practical aspects of waste strategies can be developed and new initiatives monitored. Parfitt *et al* (2002) gave several examples of analysis using their database that could inform waste strategy development. The data was clustered based on the relative use of the different outlets for household waste, which illustrated variations in total waste arising and total recycling by round day cluster, as illustrated in Figure 4.12. GIS was then used to explore different scenarios in relation to recycling targets, and predict in which of the collection day rounds multi-material kerbside collection could be introduced to give the greatest improvement in recycling performance (Parfitt *et al*, 2002).

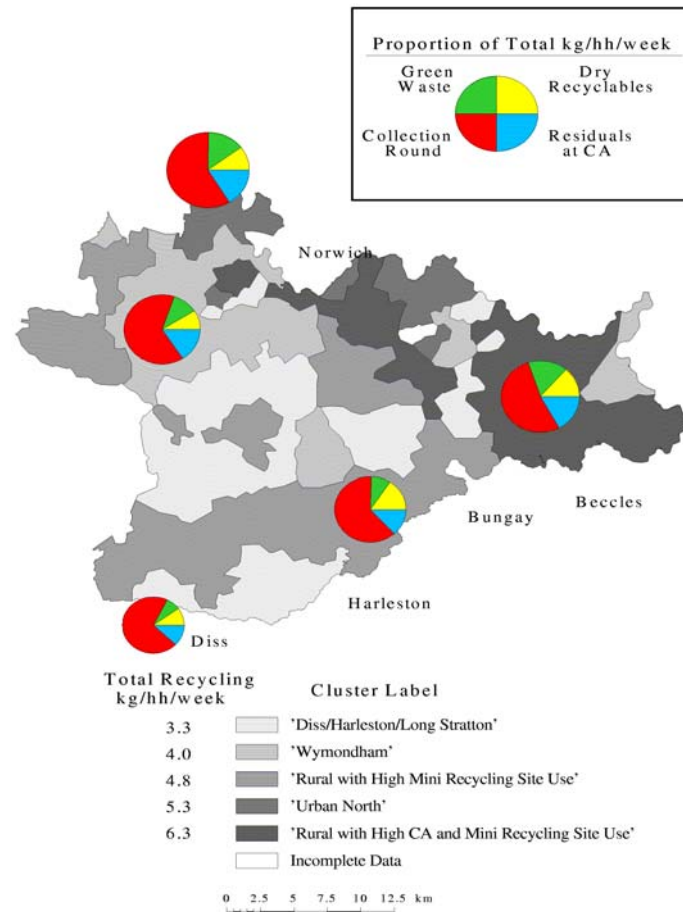


Figure 4.12 - Variations in total waste arisings and total recycling for South Norfolk study (Parfitt *et al*, 2002)

Identifying specific areas that could have the greatest impact on recycling performance clearly has implications for more efficient and effective allocation of resources. For instance, authorities are increasingly implementing kerbside collection of green waste in response to statutory recycling targets (Slater *et al*, 2001). Authority wide kerbside collections are likely to divert green waste previously taken by householders to CA sites. Authorities seek implementation strategies that minimise this diversion, so that kerbside and bring are complementary rather than competitive systems, and GIS could be used to help achieve this.

In principal the sub-district level could be further divided for individual street level analysis. If authorities have waste and recycling data for individual households, then this could be incorporated into GIS using unit sector post-codes (approx. 30 houses), or could be even more specific if GPS co-ordinates were obtained for each household. In theory, this means that waste arisings and recycling behaviour could be monitored at a street and household level, allowing, for example, authorities to give positive reinforcing feedback to existing recyclers, and specifically target those households not participating in kerbside schemes. This may be

particularly relevant for authorities that have already achieved relatively high levels of recycling through the introduction of borough wide schemes, but need to specifically identify and target non-participants to increase recycling performance.

Although GIS has not been used to this level in the UK to date, there are some trials underway in London where environmental officers are using integrated GIS and GPS mobile systems to monitor waste and environmental issues on the streets of Westminster (ESRI, 2002). Using GIS for street level waste and recycling analysis would require comprehensive data collection specific to individual streets, or individual collection rounds (e.g. as used by Parfitt *et al*, 2002). This is more detailed data than that currently compiled by most authorities, and would be time consuming and expensive to collect. However, initiatives are beginning to emerge that could be correlated with GIS to provide such data sets. For example, computerised bar code systems that read quantities collected from individual households could be combined with GIS to develop local level data sets, which could then be used to inform local level recycling initiatives and monitor performance.

4.4 Summary and Conclusion

Over the past few years there has been increased use of GIS in decision making for public service provision. In partnership agreements with OS, all central government and local authorities have access to digitised map data for their particular area, onto which they can map their own data for illustrative and analysis purposes. The largest growth area in GIS use is in land-use planning, transport and health provision, and to-date there has been limited use of GIS for waste management and recycling.

One of the drawbacks of GIS is their expense, in terms of professional software systems, technical know how and relevant data. However, most local authorities already have the software systems in place, which are increasingly accompanied by dedicated technical personnel. Whilst expanding GIS use within local authorities to encompass waste and recycling services will undoubtedly require additional resources in terms of expertise, the bulk of the software and technical resources needed are already in place. As authorities seek to improve recycling performance, there has been an increasing trend in gathering waste related data; nevertheless, unless the data was intended for GIS use, it is unlikely that it will be spatially referenced. Some data, such as quantities collected from specific bring or civic amenity sites could be spatially referenced and incorporated into GIS with minimal effort, using either unit postcodes or a geographical positioning system. However, kerbside collection data may be more difficult to spatially reference if data has been collated on aggregated quantities. If the GIS use in waste management is to develop, it is important that spatial requirements are considered at the data collection design stage.

This Chapter has outlined the nature and underlying principles of GIS, and discussed some of the potential applications GIS could have for waste management and recycling. These applications include data storage, monitoring and analysis at the national, regional and local level. Local authorities' waste strategies need to be based on a detailed understanding of waste arising, composition and flows. GIS is a powerful tool that could be used to advance this understanding and to provide a framework for developing waste and recycling strategies.

Chapter 5 — Understanding Public Participation when Developing Strategy Plans

5.1 Introduction

An important aspect in the effectiveness of any recycling scheme that involves some element of source segregation by householders is public participation. An understanding of this needs to play a key role in strategic planning, not only in assessing the current performance of any recycling scheme but also in identifying where to target improvements and assessing potential for improvement. The level of participation in a scheme is obviously critical to success; however it is not just how many people participate that is important, but also how well they do so, i.e. how effectively they participate.

Participation in kerbside schemes is most commonly measured by the participation rate, which is the number of people who put out materials for collection over a 4-week period as a percentage of the total number served by the scheme. This reflects the level of public co-operation and understanding of the scheme, as both are needed to engage participants. Another aspect of public understanding is reflected in the quality of participation of participants in a scheme, and can be measured by a term defined as separation efficiency (ERRA, 1993). This is the percentage of targeted material correctly sorted and separated by participants in a scheme, and relates to diversion in the equation:

$$\text{Material recovered} = \text{amount of targeted material in waste stream} \times \% \text{ of households participating} \times \text{separation efficiency (McDougall *et al.*, 2001)}$$

Thus showing that, both numbers participating and the quality of that participation are important. Knowing how many people participate, and where participating households are, can inform campaigns to increase participation. Knowing how well people understand how to participate in a scheme and what they choose to do about it is invaluable evidence for local authorities in identifying where and how to target public information campaigns and effectively improve quality of participation. Both measures should contribute to increasing the quantity of material diverted cost effectively.

This can be illustrated by considering potentially achievable recycling rates. Figure 5.1 was derived from the recycling performance data gathered in the case study research. Assuming as a base line that all commonly recyclable materials (wet and dry) from household waste are recycled by a kerbside scheme and that all of this material was captured, then around 68% of household waste in this case could be potentially recycled. If such a scheme achieved a high level of participation, say 85%, then as the chart shows 57% of all collected household wastes would be the maximum that could be potentially recycled by that particular scheme, provided all participants fully understood and fully complied with the scheme. However, taking into account levels of understanding amongst participants and their willingness to separate all that they recognise as recyclable shows that this has a significant effect on diversion. By assuming a separation efficiency of 65% based on levels of understanding measured in the case study area, the amount now potentially recyclable is only 37%. Even if numbers participating are high, a kerbside scheme still needs a high level of separation efficiency to get a good recycling rate, and levels of understanding amongst participants gives a measure of separation efficiency. This shows the potential significance of understanding to performance and meeting recycling targets.

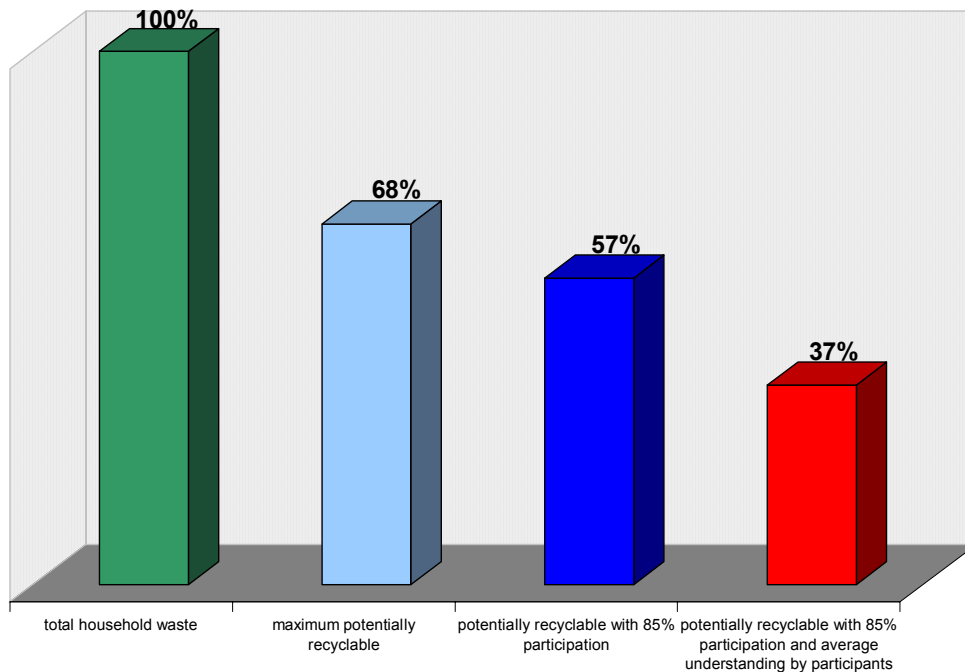


Figure 5.1 How much can be recycled?

In considering how to improve performance in source-separation recycling schemes through increased participation the focus has most often been on finding out why people do or do not participate, and on their motivation and attitudes towards recycling and other environmental issues, as mentioned in Chapter 3. The extensive literature in this field is well summarised in Berger, 1997; Coggins, 1994; De Young, 1988-9; Ebreo and Vining, 2000; Everett, 1996-7; Franco and Huerta, 1997; Tucker, 1999; Tucker *et al*, 1997; Vining and Ebreo, 1990; Waste Watch, 1998; and Watts and Probert, 1999. Much of this research has tried to build up a profile of the recycler and non-recycler to relate behaviour to demographic variables; attitudes to and understanding of recycling and environmental issues; the influence of education and publicity materials; and the effect of the design of the recycling schemes available. The assumption being that understanding attitudes and behaviour will inform how to either design services to better engage participation or how to communicate and educate the public to change attitudes and behaviour.

This research though mostly does not distinguish differences *between* recyclers – from those marginally motivated to participate to those who fully comply with a scheme's requirements. It mainly focuses on why and how many people participate, and attitudes as predictors of behaviour are important in determining how to motivate people to participate. How well they participate is no doubt also related to this, as it will be to convenience and ease of participation, but it will also be dependent on another factor, understanding. If households aren't participating fully then is it because the scheme's design makes it difficult for them to do so? Is the scheme demanding too much in terms of effort and time from participants – do people choose not to do everything asked of them? Or are participants willing but not understanding fully what is required of them?

Aspects of participation that it is important to measure include:

- Numbers participating – both the overall participation rate (of households participating at least once in a four week period) and the set-out rate (the proportion of households putting materials out for collection in any one week).

- How effectively people are participating – a measure of this can be calculated from the numbers participating together with the amount of recyclable material captured, which can be derived from data on the amount collected, both weight and composition. Other measures that give an indication of this include reject rates for the collected recyclables either measured at the MRF or as collected through observational studies of participation and what materials (such as how many types) are set-out for collection.
- Levels of public understanding – to probe why people do or do not effectively participate in particular schemes and how participation might be improved. This can be gained from analysis of public attitude surveys and public involvement strategies.

Measuring performance and participation rate on a very local basis is especially important in understanding how local variations in the type of collection scheme and socio-economic factors influence the performance of individual collection rounds, as overall scheme performance can obscure important differences. The research evaluation was undertaken jointly by the University of East Anglia and the Open University (Parfitt and Thomas, 2001) of all aspects of kerbside recycling performance and scheme costs for the Peterborough Regional Recycling Cell (covering Peterborough City Council, Wellingborough District Council, South Holland and Huntingdonshire). This programme involved the use of a geographical information system (GIS) to map the individual kerbside collection round boundaries and to integrate population data and social survey data with key kerbside performance measures (examples from this research are illustrated in Chapter 4). As discussed in Chapter 4, the use of a GIS allows spatially referenced data (such as collection round boundaries and the location of 'bring' sites) to be integrated with key performance indicators (such as household participation rate) and relevant population data (such as socio-economic groupings, mean household size and the presence of young children).

The study involved three different monitoring exercises:

- Reject analysis: quantification of the rejection rate of green box materials arriving at the MRF from the collection rounds
- Observational study of householder set-out and participation rates and measurement of the quality of participation through the number of targeted material categories put out for collection
- House-to-house questionnaire survey measuring attitude and awareness of the kerbside scheme

The research found that in Peterborough participation rates ranged from less than 30% to nearly 90%, and were broadly related to relative affluence. With such variation the importance of evaluating the performance of different collection rounds within a scheme becomes clear. Furthermore, households within areas of lower levels of participation were found to put out fewer of the different types of targeted materials than their counterparts in areas with higher participation. In examining the quality of participation, these findings suggest that in less affluent neighbourhoods the quality (as well as the extent) of participation is reduced. The reason why though is not clear from these results alone: is it lack of understanding, or lack of time or interest?

Measuring the amount of what is collected for recycling, the composition of the separated material, undertaking MRF sorts and calculating reject rates, can all tell us how well people are separating their waste and how much of the available recyclables are being captured. But it cannot tell us whether participants understand what they should do and choose not to do it because it is too much trouble, or whether they are sufficiently motivated but do not fully understand what they should be doing. Public attitude survey research can be used to assess such levels of public understanding. Public understanding can be measured by use of specific

questions in the public attitude survey to explore the respondent's recognition of the scheme's requirements. Attitudinal data will help to identify the barriers to the quality and extent of householder participation and any deficiencies in their understanding of its operation. Knowing how well people understand how to participate in a scheme, and what they choose to do about it, is invaluable evidence for local authorities in identifying where and how to target public information campaigns and effectively improve the quality of participation, and hence the quantity of material diverted cost effectively.

5.2 Levels of Understanding and Recycling Performance

This Chapter looks specifically at using public attitude market research to give insight into how effectively recyclers are participating, and examine levels of understanding amongst participants of different kerbside schemes.

The analysis should explore the levels of understanding that exist, and to look for relationships between these and:

- the importance of a variety of design parameters (for example: frequency of collection and the provision of containers);
- the effects of targeting different materials for recycling (that is how many and which materials a scheme aims to recover); and
- the role played by publicity and education strategies in determining participation levels.

The approach taken in this research is described here and in Insert 5.1, with further specific details about the case study results detailed in Inserts 5.2, 5.3 and 5.4.

Public understanding was measured by use of questions in the public attitude survey to explore the respondent's recognition of the scheme's requirements. Each scheme has its own features and variations although roughly falling into five different types as defined by differences in the containment given to householders for recyclables and frequency of collection. The schemes investigated use wheeled bins, plastic boxes, bags or no containers, have weekly or fortnightly collections, take a variety of dry recyclables and in one case organic wastes (both garden and kitchen waste) as well.

What the measure of public understanding or recognition of materials recycled shows is how well those already participating in a kerbside scheme do so; it does not show how many people participate (this is given by the participation rate) or what those not participating understand of the schemes.

Analysis of public understanding in the case study indicated a number of areas where recognition differed between schemes. However the interactions between the many influencing factors on participation are complex and do not indicate simple cause and effect relationships. The results show average levels of the public correctly recalling which materials were targeted for recycling varying from 44% to 85% in different districts, but without showing any significant correlation with different design features such as container type or collection frequency. Indeed few distinct correlations showed up in the analysis. Some individual actions such as reminders on containers appeared to work to increase levels of understanding; also the results indicated that the complexity (in what is demanded of participants) of a scheme can affect understanding. What this analysis attempted to do is to indicate where individual influences contributed to better public understanding and hence to increase the chance of better quality of participation from those involved.

Insert 5.1: Hampshire case study – aims and method of public understanding evaluation

Project Integra undertook extensive public attitude market research with a view to investigating amongst many issues the reasons for participation or non-participation in recycling (Project Integra, 1999). This research analysed resulting data with a focus on the relationship between communication strategies and design variables, in eleven kerbside schemes operating in different districts within Hampshire, with levels of public understanding found in each district, and included:

1. Filtering the results by district and analysing recognition of what materials respondents are asked to separate for recycling, in relation to information that each district provided to householders telling them what to recycle;
2. Relating this to the waste analysis data for each district, diversion rates and participation data from the questionnaires (and in discussion with Recycling Officers), demographic information, scheme design variables (such as materials targeted for collection, frequency of collection, containers provided or density of collection sites), and the information strategies employed; and
3. Carrying out a preliminary assessment of communication effectiveness in discussion with Recycling Officers, and including these results in the overall assessment of public understanding and perception.

The analysis focused on the question asked in the public opinion survey regarding what materials participants in kerbside recycling schemes *were asked to separate* for recycling. This did not record whether they did or did not recycle these materials but whether they understood from the information that they had received from the Council that they should be separated and put out for collection. From the responses to this question, a measure was taken of the participants' level of understanding of the scheme requirements. The question asked for a response on 24 types of waste material, with between 7 and 13 of these being accepted for recycling.

This measure of understanding was analysed in a variety of ways in order to discover any correlation or trends that might affect public understanding in relation to participating in kerbside recycling schemes.

Overall there was a positive correlation between recognition and recycling rates showing that improvement in understanding would bring benefits in overall performance.

Analysis of material recognition by socio-economic group gave an interesting and unexpected result. It showed little overall variation in understanding amongst participants from different socio-economic groups across Hampshire. No observational studies had been carried out to match quantities of recyclables and reject rates to these data, so it is not possible to know to what extent respondents' stated understanding translated into full compliance with each kerbside collection's requirements.

The role played by public information and education in determining levels of understanding was also examined. An assessment of the communication strategies used in each district and the impact that these had on understanding amongst participants was undertaken. This is a complex and interactive area where it is difficult to isolate individual causal relationships; however some trends emerge, such as reminders on containers appeared to increase levels of understanding (Thomas, 2001a).

Insert 5.2: Hampshire case study – summary of context for recycling schemes

Scheme performance will be affected by many aspects of its history, design and communication strategy. Those factors that were considered most likely to affect public participation include ease of participation – such as type of container provided, frequency and convenience of collection, what materials are collected and hence perceived time and effort to source separate the required recyclables; publicity and information provided; history and context of the scheme – whether it is newly introduced, established or undergone some recent significant changes, political factors that might influence local opinion; and socio-demographic influences.

The following brief description summarises the variations in these factors found within Hampshire; variations were then examined in relation to the levels of public understanding found for each of the schemes:

- Type of container provided to participants: Of the eleven schemes in Hampshire, four were twin wheeled bin schemes – one with an optional 3rd wheeled bin to account for alternate collections of wet and dry waste; three used boxes; two distributed clear plastic sacks for recyclables; and two provided no container, expecting participants to use their own plastic carrier bags.
- Frequency of recyclables collection: Five of the schemes collected recyclables weekly, and the rest fortnightly;
One important design variation is that Eastleigh operates an alternate weekly collection of residual waste and recyclables, using 140 litre bins as standard (with 240 litre bins for larger families).
- Materials collected for recycling: There were no significant differences between schemes in the range of recyclables collected. All collected newspapers and magazines, plastic bottles, and food and drinks cans – and all except three Districts took mixed paper and card. What was collected was determined by the requirements of the Materials Recycling Facilities.
- History and context of scheme: Most of the schemes had been established for more than six months prior to the period when the survey was carried out, although some had had recent expansions to some areas. Only one District – Basingstoke – was undergoing significant changes in the design of their kerbside scheme, where their plastic sack scheme was in the process of being changed to a ‘piggy-back’ bin scheme during survey period. This might have had an unpredictable effect on public attitudes at this time.
- Socio-demographic factors: Socio-economic influences were not easy to identify between Districts as the data collected mostly involved samples which were too small to allow valid comparisons, although some trends across the county were examined.
- Publicity and information provided to residents: This is a difficult area to quantify but there are elements in the approaches taken that can be highlighted. Similar approaches are used by all Districts to publicising schemes and providing information to residents – focusing on packages of information to residents prior to or at the launch of a scheme in a new area; sometimes followed by a mixture of reminder leaflets, stickers as reminders on recycling containers, articles in council’s newsletter or magazine, publicity through logos displayed on containers and vehicles, and articles in local press; Some areas provide reminders for participants to keep – these might be in the form of printed bags or stickers for recycling containers which provide a regular reminder each time the participant engages in recycling something, or as calendars or leaflets that can be kept (or lost);
Most Districts provide some educational visits to schools and community groups, some more intensively than others; whilst some focused more on providing a personal interface with the public – going out and talking to people, listening, being visible in their communities;
Other approaches – such as posters in public places including notices boards and information points, on public transport buses and in bus shelters.

Insert 5.3: Hampshire case study - key performance indicators

Some key performance indicators for the Hampshire districts included in the study are shown in Table 5.1.

self-reported participation rate is the % of surveyed respondents who are served by a kerbside scheme that claimed to participate

capture rate is the ratio of the amount of targeted recyclable material collected from participants to the total amount of targeted recyclable material available from participants; is the same as the ratio of the recovery rate to the participation rate; and also called the separation efficiency

recovery rate is the ratio of the amount of targeted material recovered from the householders served to the total amount of targeted material available in the waste stream from the householders served x 100

Table 5.1: Performance Indicators

	self-reported participation rate	capture rate	recovery rate
Fareham	94%	52%	49%
Hart	94%	57%	54%
Eastleigh	95%	76%	72%
Portsmouth	79%	47%	37%
East Hants	67%	74%	50%
Havant	88%	52%	46%
Basingstoke and Deane	91%	36%	33%
Gosport	50%	70%	35%
New Forest	89%	73%	65%
Rushmoor	53%	54%	29%
Winchester	87%	38%	33%
Test Valley	83%	58%	48%

Districts with a high capture have participants who are more effectively separating their recyclables; where both participation and capture rate are high then this will result in a high recycling rate for the district as well. Conversely where participation is low, even a high capture rate results in a low recycling rate.

It should be noted that self-reported participation rates are not an accurate measure of participation as it has been shown that people widely overestimate their behaviour in this respect (Woollam *et al*, 2003)

These regular reminders provided by either printed bags or stickers to put on boxes or lids of wheeled bins to prompt households about what materials to recycle, did show a correlation with higher levels of understanding.

Overall the results indicated that the complexity of a scheme can affect understanding. Schemes collecting mixed paper rather than newspapers and magazines only tended to have higher levels of understanding. In this case increasing the range of materials targeted simplified what the householder needed to do. Research carried out on a kerbside scheme in Milton Keynes also showed that increasing the complexity of the range of materials targeted led to reduced effectiveness and lower diversion overall due to achieving a lower level of understanding (Thomas, 2001b). This relationship between complexity and what is demanded of participants is an important factor in relation to effective participation.

Insert 5.4: Hampshire case study – selected results

- No distinct or strong correlation was found between container type and level of understanding amongst participants, although it appeared that the twin-bin schemes all performed well, and ‘no container’ schemes less well than others.

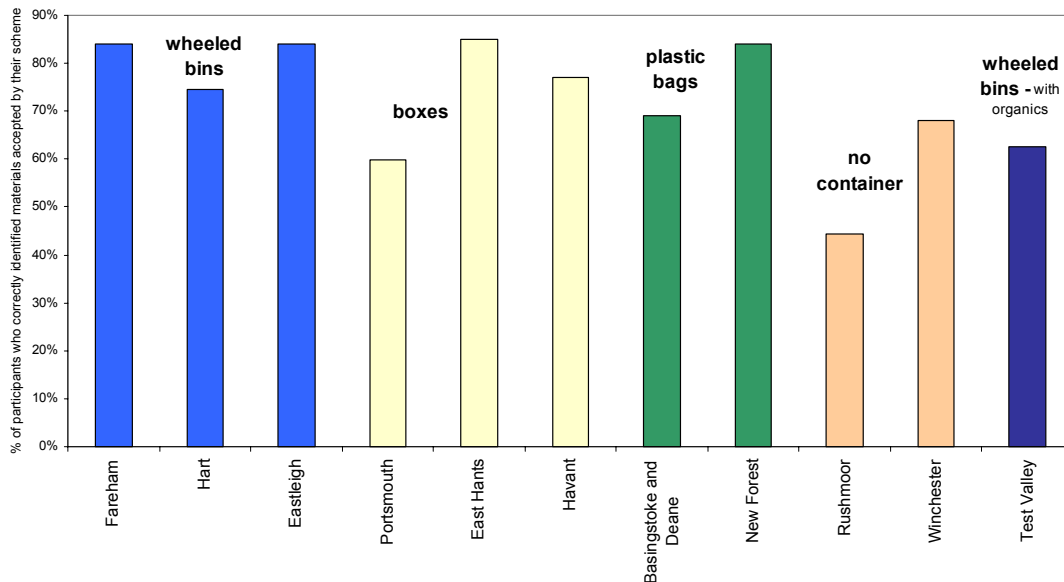


Figure 5.2 Container type and understanding

- No significant differences were found between schemes having weekly or fortnightly collections.
- Regular reminders, provided by either printed bags or stickers to put on boxes or lids of wheeled bins, to prompt households about what materials to recycle, did show a correlation with higher levels of understanding, as shown in Figure 5.3. This was further emphasised in Rushmoor (which does not provide information on the container and has the lowest average recognition levels) where residents reported in the attitude survey to feeling less than other districts that the council reminds them what to put out for recycling (Project Integra, 1999).
- Complexity of a scheme can be related to lower levels of understanding, with Test Valley one of the more complex to participate in having a lower average level of understanding than other wheeled bin schemes. In the attitude survey responses participants in Test Valley were “significantly more likely to be confused than others” and are more likely to “not be bothered to sort their waste out” (Project Integra, 1999).

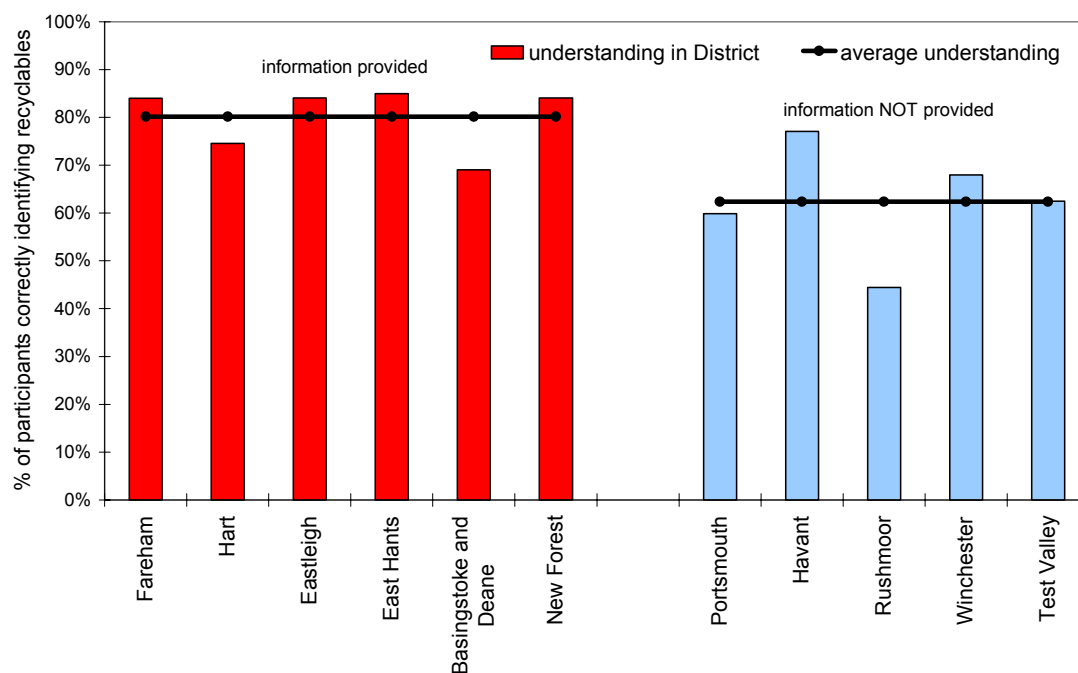


Figure 5.3 Effects of provision of information reminders on containers

- There was considerable variance in how well different recyclables were recognised as targeted by kerbside schemes, as shown in Figure 5.4. Newspapers and plastic bottles were identified most often. Magazines and cereal boxes were also well recognised in schemes which took mixed paper, but there was some confusion regarding the acceptability of magazines in those areas which didn't take mixed papers and card. There was a lower level of understanding that cans should be recycled; for drinks cans, and in particular pet food cans. Also the levels of understanding that glass was not accepted could lead to unacceptable contamination if participants were including these in the recyclables that they put out for collection.
- that socio-economic differences between Districts would not explain differences in levels of understanding amongst participants in these Districts.

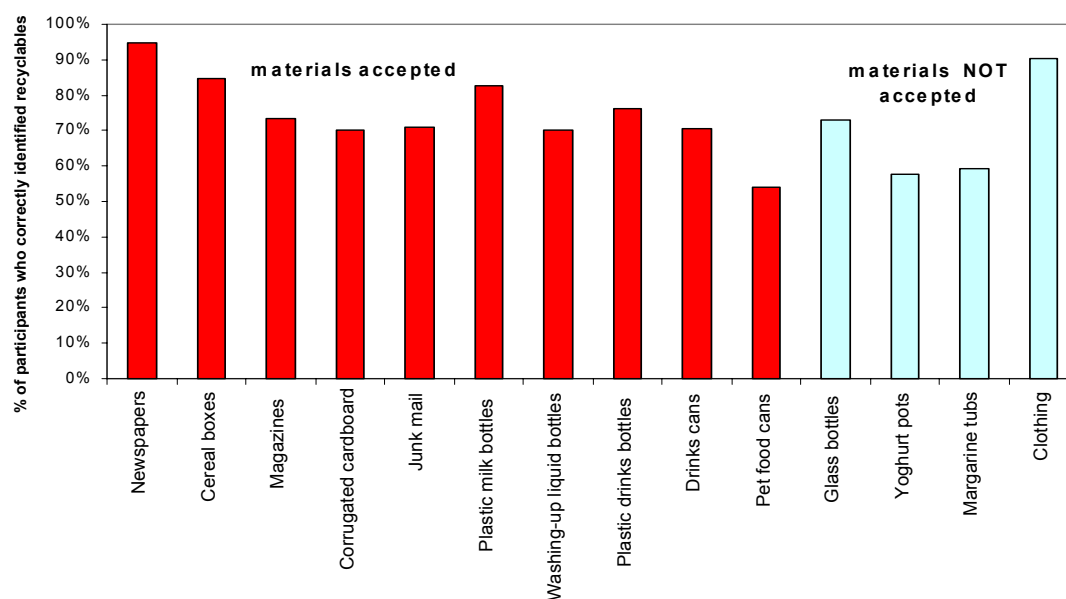


Figure 5.4 Recognition of different materials for recycling

5.3 Summary and Conclusion

The role of public participation in improving recycling performance both in terms of numbers and how effectively materials are captured has been explored in this Chapter. It clearly shows the importance of generating local data on participation, and calculating locally relevant capture rates as significant differences can arise at sub-district levels as well as between districts.

The effective monitoring and evaluation of kerbside recycling schemes should involve the close integration of different categories of data, including questionnaire data on public understanding. Most attention is usually given to the measurement of key scheme ratios, such as diversion and recovery rates, and the estimation of participation rates. However only when performance data are analysed together with social survey data does a complete picture emerge of how public understanding influences scheme performance. Where this is the case, performance improvements can be better planned, and hence limited resources used more effectively as promotional campaigns can be more accurately targeted.

Analysing public understanding relating to which materials could be separated for recycling in Hampshire, identified a distinct lack of awareness in certain districts that magazines were collected for recycling. This information, together with data on what was being collected for recycling from different districts, informed a targeted publicity campaign by Hampshire CC to promote magazine recycling to the public in those areas. Posters were displayed at railway stations and in bus shelters to target commuters, complemented by radio messages, and articles in local newspapers, persuading them, "When you've read it, recycle it". In the two districts where capture was the lowest, bin stickers reinforcing the message were distributed. The promotion was also spread throughout the county through press releases and articles, in local newspapers and in some parish magazines. This targeted campaign was evaluated both for impact of the media and images used, and effect on recycled tonnage. It was found that in the period following the campaign that the tonnage of recycled paper collected in the two targeted districts increased at least 12% in comparison with the rest of Hampshire (HCC, 2000)

Other issues emerged concerning the relationship between ease of participation, the range of materials targeted and degree of separation required by participants, and how well the message is communicated, and the quality of participation achieved. Experience from the Milton Keynes study showed that increasing the range of recyclables collected by a scheme without achieving a good level of understanding amongst participants of what they are being asked to do will not lead to improved diversion. The results from the study of kerbside recycling in Hampshire indicated that the complexity of the scheme and how well the message is communicated were important factors in determining understanding.

But how can we best improve understanding, and hence the quality of participation? Publicity, information and education will no doubt affect public understanding of participating in recycling schemes – but how does it do so, and what approaches are most effective? Further research is now needed to examine, compare and evaluate different communication strategies in terms of how they impact on understanding and quality of participation. This should also address the issue of whether it is better communication, or making the scheme physically easier to participate in that is the key to improving understanding? Measuring and monitoring participation will help answer these questions, as this Chapter shows.

Chapter 6 — Compositional Data to Improve Strategy Planning

6.1 Introduction

This Chapter describes a methodology for collecting and analysing composition data that allows data collected from different household waste streams to be integrated to give a profile of the total municipal waste stream. Data integrated in this way will give a more accurate basis for evaluation of performance and planning to achieve recycling and other targets.

Local waste management strategies need to take into account all household waste arisings, including those taken to Civic Amenity sites (where householders can deposit at no cost waste materials including those not collected in the regular refuse collection such as garden DIY and bulky wastes) and 'bring' facilities (such as glass and paper banks in supermarket car parks). Collected household or 'dustbin' waste accounts for only around 60% of total household waste, with CA sites wastes comprising another 15%. It is unrealistic to assume that the total household waste stream therefore will conform to the characteristics of one part of the picture, albeit a majority one. However research has consistently failed to integrate site-based data with collection round data. Research that deals with one aspect of the household waste stream in isolation can build a misleading picture of the amount and type of waste produced by households in any particular area. This can prove a serious weakness in the development of realistic waste management scenarios, and lead to unrealistic choices for future strategy. This point is addressed in the recent working/ research paper for the Cabinet Office's Strategy Unit on the analysis of household waste composition (Parfitt, 2002), which is introduced with the sentence "There is much confusion over the meaning and validity of household waste compositional statistics in the UK". It goes on to comment that "compositional studies in the UK have focused almost exclusively on establishing the composition of residual 'dustbin' waste" and consequently that 'dustbin' or collected refuse data is often misconstrued as representing the composition of all municipal waste arisings. And as a result "the lack of credible national estimates (for waste composition) has important implications for the development of waste policies".

Although this is commonly accepted, very few studies of household waste composition attempt to analyse or reconstruct the whole household waste stream to give a clear picture of how much of each type of material is present in the waste that households in an particular area discard or recycle. Most studies that sample household waste arisings, even recent ones, focus on analysing collected residual and kerbside recycled waste (DOE, 1994; Parfitt, 2000; and Parfitt and Flowerdew, 1997). Some authorities have undertaken compositional studies at CA sites, usually sampling and analysing materials brought in per site visit, and recent studies include those by the National Assembly for Wales (2002), Milton Keynes Council (2000) and Project Integra (1999). However data on this waste stream is limited, and although weight data is combined to give total waste arisings, compositional analysis of CA site waste is rarely integrated with that from collected wastes. This however is beginning to change especially since research undertaken for the government's Strategy Unit produced a national average composition for household waste including 'bin' waste, recyclables and CA site waste. This study used a methodology developed from that described in this Chapter, but using a different and more extensive data set.

Local authorities collect data on the amounts of each material recycled at bring and CA sites for their own use and for the DEFRA collected national waste statistics and the Audit Commission's Best Value Performance Indicators (BVPI) tables, but these do not include overall composition of wastes delivered to sites. At the Waste Disposal Authority (WDA) and Waste

Collection Authority (WCA) level this data is combined to show overall total tonnage of household waste produced including collected, bring and CA sites (DEFRA, 2002), but again this data doesn't provide information about its composition.

What is missing from this picture are attempts to combine the compositional analyses, at a local level, of each of these waste and recycling streams – collected refuse and recyclables; and materials taken to CA and bring sites. Reconstructing the waste stream back to an average individual household should take account of all the materials produced by that household entering waste and recycling streams.

Householders in area A may only use the waste collection services, putting all their refuse into wheeled bins, whilst in another area B, householders may take regular trips to CA sites and recycling centres. Unless this is taken into account area A will show a higher amount of waste per household collected than area B and a different composition.

The methodology was developed from, and based on research carried out in collaboration with Hampshire County Council and Project Integra. This research set out to integrate their operational data on the relative use of the different outlets for household waste with compositional data from a limited sample of waste collection rounds and CA sites. It is recorded here both in the description of the methodology developed and in the case study of the composition of Hampshire's household wastes. From this exercise a method of integrating compositional data to provide a profile of the total household waste stream was developed. The main body of this Chapter describes the methodology developed, and details of the Hampshire case study are included in Inserts throughout the Report and in Appendix 3.

6.2 Development of a Methodology for Integrating Compositional Data on Household Waste

6.2.1 *Data sources for integration*

Local authorities collect a variety of operational data on their waste collection and recycling services. Some is essential to providing annual returns to national government departments, including DEFRA and ODPM, and in order to calculate their Best Value Performance Indicators (BVPIs) and other indicators; others are collected for internal auditing and accounting purposes. The variety and thoroughness of data collection varies considerably from authority to authority, as does the compatibility of different data sources collected and the analyses performed on this data.

In the case study, a wide variety of data was available from Project Integra in Hampshire on its waste management activities. Their acquired data includes weighbridge data, recyclable materials sales and recycling credits as well as undertaking specific data gathering and research projects both at county and district level (see Insert 6.1).

To build an accurate picture of the composition of household waste needs not only for that waste to be sampled and analysed into its component materials, but for accurate information on the amounts of waste generated in the area being studied. This requires both compositional studies and operational data on the various household waste streams.

6.2.2 *Weight data*

The operational data needed for validating and determining composition of the total integrated household waste stream will include weight data, on a district and per household basis, for:

- collected (often called 'dustbin') residual household waste
- kerbside collected recyclables

- bring site recyclables, by material type
- CA site wastes – including residual waste and recyclables
- Other collected wastes – i.e. bulky wastes, litter

This data can be taken from the DEFRA annual returns made by the authority, or other operational data base sources held by the authority. In the latter case the data should be checked against the DEFRA figures for validation and consistency in the data.

6.2.3 *Compositional data*

This operational data provides overall weight information, but not the composition of the various waste streams. Compositional analysis requires a research and sampling programme to provide locally based information, and a detailed study of waste composition of sampled wastes in the authority should be carried out if possible to provide data as locally accurate as feasible. This should test sufficient samples to be statistically significant, provide coverage that is representative of different collection infrastructures and recycling provisions in the borough or county, as well as socio-demographic profiles, and cover more than one season.

There is no nationally agreed protocol for carrying out these studies and consequently it is often difficult to compare studies in different authorities, or to know the reliability of the compositional profile obtained. This lack of general guidelines on the essential methodological requirements for compositional research studies undertaken by individual local authorities was addressed by the recent Strategy Unit report (Parfitt, 2002). In this study of 70 compositional analysis data sets, it was found 'methodological differences to be one of the main factors behind the wide variation in the quantities of different materials measured in the compositional analyses'.

Studies vary in which waste streams are sampled, the categories used to classify composition, numbers of samples taken, whether samples are taken in more than one season, how samples are taken, and how many different types of neighbourhood are sampled.

Including samples from more than one season was found by the study for the Strategy Unit to be a major factor in influencing how representative the findings were of the districts overall waste arisings, at least by weight, when correlated with annual DEFRA data. In particular it was concluded that single season studies were unreliable, and likely to be a poor guide to overall annual waste composition, with spring/summer samples often giving higher weights collected than annual averages, whereas autumn/winter samples tend to be below average.

Sampling techniques can themselves lead to differences in the composition found.

Compositional analysis by the household bin-sort method was concluded by Parfitt *et al* (1997) to be the best method for obtaining detailed data on household waste composition as required for identification of the packaging, compostable and recyclable elements. This method has advantages over the bulk sampling technique in that materials can be identified in their 'as disposed' form and the results can be directly related to household characteristics. Bulk sampling and mechanical handling can also lead to increased proportion of 'fines' in the composition analysis. The main strength of the collection round bulk sample technique is its ability to process large quantities of household waste and to highlight differences between neighbourhood types.

Insert 6.1: Hampshire case study – data sources available

Data available on waste arisings in Hampshire included operational, research studies and DEFRA statistics:

1. Hampshire County Council, Portsmouth and Southampton Unitary Authorities, and the eleven WCAs, as well as Project Integra, all keep detailed operational data on Waste Management activities. Hampshire C.C.'s operational data summarises all waste arisings at a district and Civic Amenity site (known as Household Waste Recycling Centres or HWRCs in Hampshire) level, with some breakdown into major categories of wastes and recyclables. This operational data, most of it on a monthly basis but with some relating to annual totals, includes:
 - collected household and non-household waste for each district
 - kerbside collected recyclables for each district
 - wastes at HWRC sites (recyclables by 11 categories, green waste, and residual wastes for disposal)
 - materials from 'bring' sites (as determined from recycling credit returns and information sought from districts by the C.C.)
 - information on the allocation of HWRC site waste to each district from Hampshire C.C.'s HWRC user survey data
 - demographic information from postcode data related to sample rounds and HWRC location
2. The most comprehensive recent research was the Project Integra Household Waste Research Programme, undertaken in 1999 (Project Integra, 1999). Data from this included quantity and compositional analysis of residual waste and recyclables from 31 sample rounds in total – 2 or 3 from each of the 13 districts within Hampshire. All samples were taken over a period of 1-2 months, making this a single season study.

These samples were analysed into a total of 167 waste compositional categories, grouped into 40 major categories and then into 11 more general categories. Each sampled round consisted of analysing the waste collected from a sample of approximately 500 households from an area with a specific ACORN classification. ACORN (A Classification of Residential Neighbourhoods) is a system of socio-demographic profiling. These mostly reflect the predominant ACORN groups within each WCA/UA, but are not necessarily representative of each area's overall socio-economic profile. These data chart both collected refuse or residual waste and kerbside collected recyclables; they do not account for household waste taken to either HWRCs or household waste materials taken to 'bring' sites for recycling.

The Project Integra research also included a survey and analysis of users visiting four of the 26 HWRC sites in Hampshire. This sampled HWRC compositional analysis was undertaken at the same time as the collection round sampling. Although these data give a detailed compositional analysis for each specific sample, it is based on per site visit analysis; and it is not possible from the nature of the data and sampling method to derive an accurate picture of either total household waste arisings for households in that sample, or a district level compositional analysis directly. All this sampling was unfortunately single season, with its associated problems of being representative.
3. DEFRA national survey data, as published in the 'Municipal Waste Management Statistics' each year, was available for each WCA and WDA in Hampshire.

Which wastes should be sampled for composition, and which categories recorded? Most studies analyse collected residual ('dustbin') waste, and often also kerbside collected recyclables as a separate stream. These are important elements of the waste stream, with residual collected accounting for something like 60% of household waste nationally. However it is also important to also analyse the composition of the 15% of household wastes taken to CA sites (Parfitt, 2002). CA site compositional analyses where carried out usually focus on sampling per site visit on a specific day or days and calculating composition from this data. To build up an accurate picture of CA site use and total household waste composition at a local level (such as at district or even sub-district level) then it is important to know the patterns of CA site use by householders. This includes which CA sites householders in a particular area use and what proportion of those CA sites wastes comes from those households. From this, cross-border use of CA sites can be accounted for and CA site wastes from a particular area identified sufficiently accurately to integrate this data with collected waste data.

Different compositional studies use different material categories to define composition, although there are similarities and standard groupings used in most studies. Deciding what is important about composition and consequently what categories to assess, are dependent on the use to which the analysis will be put, although choices may also be constrained by data limitations. For example if an authority is considering introducing a kitchen waste collection they will want to know how much of their collected putrescible waste is compostable kitchen waste and how much garden waste. Equally, knowledge of specific recyclable materials such as newsprint and card will be of interest if a recycling scheme is planned whereas a crude knowledge just of the 'paper fraction' may be sufficient for planning an Energy from Waste plant. Here concern will focus on the amount of combustible material in household waste, and its calorific value.

Several accepted categorisations have been developed including those by Warren Spring Laboratory and MEL Research Ltd. The Warren Spring Laboratory categorisation of household waste was strongly influenced by the work undertaken to assess the RDF (Refuse Derived Fuel) potential of the waste, and the result was a core set of 11 categories, supplemented by a chemical assay to allow potential combustion characteristics to be assessed. The core set of 11 was extended by a sub-division to a second group of categories to accommodate the more exacting requirements of recycling. The resulting 33 sub-categories (the WSL 33) were those subsequently adopted for the National Household Waste Analysis Project (WSL & Aspinwalls, 1993; Crichton and New, 1994). These are listed in Table 6.1.

The Project Integra original compositional research study was carried out by MEL Research Ltd and used their classification of compositional categories as detailed in Insert 6.2. This included 11 main categories and 40 more specific sub-categories that, as can be seen, have the same 11 main categories and many similarities in the more detailed classification as with the Warren Spring categories.

Table 6.1 Material classifications developed by Warren Spring Laboratory

11 Component System	33 Component System
Paper and card	Newspapers Magazines Other paper Liquid containers Board packaging Other Board
Plastic film	Refuse sacks Other
Dense plastic	Clear beverage bottles Coloured beverage bottles Other plastic bottles Food packaging Other
Glass	Brown glass Green glass Clear glass Other
Ferrous metal	Beverage cans Food cans Batteries Other cans Other
Non-ferrous metal	Beverage cans Foil Other
Textiles	
Putrescibles	Garden waste Other
Miscellaneous combustibles	Disposable nappies Other
Miscellaneous non-combustibles	
Fines	

(Source: Atkinson and New, 1993)

The recent Strategy Unit study (Parfitt, 2002) uses broadly similar categories but with some distinct differences to account in particular for CA site wastes that do not resemble collected household waste. Its 29 categories are listed in Table 6.8, and aggregated 13 primary categories given below in Table 6.2. Other classifications and variations on these classifications are seen in local authority compositional studies. Some of the common variations include:

- whether plastic waste is grouped together as ‘plastics’ or as ‘dense plastics’ (being the plastic bottles commonly collected for recycling by kerbside schemes, ‘plastic film’ and/or ‘other plastics’;
- whether metals in household waste are recorded as ‘ferrous’ and ‘non-ferrous’, or whether cans are recorded separately; and
- whether kitchen and garden wastes are separately identified or recorded as putrescible waste

Although composition of collected ‘dustbin’ waste has been analysed in some cases in great detail as the above shows, the same detail has not commonly been used to describe CA site wastes. Therefore when analysing combined waste streams, it has generally been necessary to restrict the number of categories to a minimum to account for the differences in the classifications used for the different waste streams. The categories used in this re-integration of the complete household waste stream are shown below in Table 6.2. These were chosen because they allow data from collected, bring and CA sites to be relatively easily combined. They are simple groupings that aggregate a number of categories and allow estimates to be made from the different classifications used for these three different waste streams. These categories identified the main recyclable materials collected in Hampshire, and so were useful in calculating and assessing recycling performance and identifying where this might be improved. They share characteristics with the primary categories in the classification adopted in the recent Strategy Unit report (Parfitt, 2002) (listed in Table 6.2) that also looked at combining collected and CA site data sets to give an overall composition for household waste.

Table 6.2 Material classifications used in composition analyses

OU classification used on PI data	SU report classification ¹
Paper & card	Paper and board
Dense plastics	Plastics
Textiles	Textiles
Glass	Glass
Cans	Metal cans & foil Other ferrous/ white goods Other non-ferrous
Garden waste	Garden waste
Kitchen waste	Kitchen waste Soil & other organic waste
Other CA site recycled (oil, batteries, wood + bric-a-brac)	
Unclassified & other	Wood & other combustibles Miscellaneous non-combustible Fines

¹(Parfitt, 2002)

Insert 6.2 Hampshire case study - compositional analysis categories

The Project Integra research study carried out by MEL Research Ltd initially analysed the waste sampled into a total of 167 waste compositional categories, which were then grouped into 40 broader categories and then again into 11 main categories. The full analysis split each major category into very specific types of waste, not only by material type but including information such as for instance whether the green glass had contained beer, wine, soft drinks or other foodstuffs. Metals were not only categorised as ferrous or non-ferrous but whether they are cans for drinks – alcoholic or soft drinks – or food, or aerosols, batteries, aluminium foil etc. This categorisation was used with a view to examining purchasing patterns and lifestyle effects on waste production. Such detailed analysis however has to be balanced against the statistical significance and accuracy of the results unless large sample sizes can be accommodated in the study.

The 40 broader categories are listed, together with the 11 main groups into which they fit, below in Table 6.3. This level of detail allows identification of the percentage of for example paper and card that could be collected by a kerbside scheme targeting certain types of paper and card. This would provide a more accurate measure of the maximum amount of paper and card such a scheme could capture than a composition analysis that only provides an overall figure for the amount of paper and card in household waste. Similarly only those plastics targeted for collection can be identified by this level of categorisation.

Table 6.3 Material classifications used in Project Integra collected waste analysis

Paper & card	Newspaper Magazines Recyclable paper (non-packaging) Card & paper packaging Cardboard	Miscellaneous combustible	Unclassified Disposable nappies Shoes Wood
	Card non-packaging Liquid cartons Non-recyclable paper	Glass	Clear bottles & jars Green bottles & jars Brown bottles & jars Other glass
Plastic film	Refuse sacks & carrier bags Film – packaging Film – non packaging	Ferrous metal	Food cans Beverage cans Batteries Aerosols Other ferrous
Dense plastic	PET clear bottles PET coloured bottles HDPE clear bottles HDPE coloured bottles PVC clear bottles PVC coloured bottles Food packaging Non-food packaging Other		Aluminium foil Beverage cans – aluminium aluminium food cans Other
		Non-ferrous metal	
		Putrescible	Garden waste Kitchen compostable Kitchen non-compostable Unclassified
Textiles	Natural and man-made fibres		
Miscellaneous non-combustible	Unclassified	Fines	Particles < 10mm

Where local data on composition is not available, national average composition data for household waste could be used in its place and applied to local weight data. The last comprehensive national programme to study nationally average municipal waste composition was carried out in 1993 (described in WSL & Aspinwalls, 1993; Crichton and New, 1994; and Parfitt *et al*, 1997). And although that data was used as recently as 2000 in the Waste 2000 strategy report, it is acknowledged not to be representative of the current situation. The most recent and reliable national average data available is probably that included in the recent Strategy Unit study (Parfitt, 2002). This statistically analysed 27 data sets of compositional studies of collected wastes carried out over at least two seasons, together with a smaller sample of CA site analyses, and validated with national DEFRA data. Results of this analysis are included for comparison later in this Chapter.

6.3 Classification of Samples for Compositional Analysis

When composition studies are carried out they will not be able to analyse all households in an area, and will involve a sampling programme from which results can be extrapolated to a larger area such as district or county. Samples analysed may derive from areas with different socio-demographic characteristics and/or different waste infrastructures, and consequently produce varying results that need averaging in some way to give an overall profile for the area. This often involves taking a mean value, or weighted mean to take account of infrastructure or socio-demographic factors. However the more complex the differences between sample areas the more complex the question of averaging becomes. Mean values could still be applied if sufficient samples exist, but it is often the situation, as it was in the case study, that too few samples are available to represent each area sufficiently accurately and to confidently deal with anomalous results statistically.

In this situation, samples can be classified by 'cluster analysis' which groups together areas with similar waste characteristics to create a generalised composition for each of the main groups or clusters obtained. Individual districts or boroughs will then usually be part of a group or cluster, whose mean compositional profile can be taken to be a more accurate reflection of its waste composition than would be produced by a simple mean of a limited set of data from that area. This approach has merit where there are only a few data points in each district or borough in reducing the overall influence of those individual data points (and in particular any erroneous data) in producing district or borough level compositional estimates.

A general objective of this approach is to classify the samples based on variables which relate as directly as possible to waste management. A more detailed explanation of the development of this classification system, its statistical basis and application to local authorities in England and Wales is given in Parfitt and Lovett (1998) and Parfitt *et al* (2001).

6.3.1 Identifying a basis for grouping the samples

Firstly the operational and sampled data should be examined for correlations and to identify possible contributory factors. In our study the summary data on composition of total waste per household for each sample was looked at in terms of the major waste fractions for each district, in relation to those factors that have most effect on total waste arisings. This enabled questions to be addressed such as "is it for example socio-economic group, the infrastructure provided for collection and recycling, or the availability and access to CA/ HWRC sites?

The factors we examined for each sample round were: ACORN group; total collected waste; HWRC use and distance to HWRC site; and the amounts of post-consumer waste, garden and kitchen waste found in collected waste. (Post-consumer waste is any waste that is product related, rather than of more general origin, and includes paper, glass, plastics and cans. Garden

waste and fines are non-consumer wastes). These were then analysed to look for any correlations between them, and the results found are summarised in Insert 6.3.

Insert 6.3 Hampshire case study – factors influencing waste composition

Two main findings from the results in Hampshire were:

- ACORN group was not found to be a particularly powerful dimension for explaining differences in total collected household waste arisings between sampled areas, even though it had been used as the basis of the sampling programme
- The use of HWRC sites was found to strongly influence the amount of collection round waste generated in an area, shown by a very strong negative correlation between total collected RCV (refuse collection vehicle) or 'dustbin' waste and the amount of waste taken to HWRC sites at $r = -0.68$ (which has particular implications for interpreting the compositional analysis)

6.3.2 Cluster analysis

A cluster analysis can then be used to classify samples by those factors found to most influence waste arisings. In this case it was the extent to which their wastes were split between collected and HWRC wastes (district-wide statistics derived from the operational database) was the predominant factor, but included these variables – total household waste, collected post-consumer waste, collected garden waste, HWRC use, and distance to HWRC site. It identified districts with similar characteristics in their waste arisings, and which should show similar overall waste composition, see Insert 6.4.

Insert 6.4 Hampshire case study - results of cluster analysis

The output of cluster membership from the case study classification produced four distinct groups of districts – an interesting result that was found to conform to the following factors:

- Individual sampled rounds for each district fell into the same clustered group
- Clusters were largely consistent with the methods of collection round residual waste containment (wheeled bin, plastic sack and no method provided)
- One distinct group contained all districts with restrictions over the collection of garden waste with collected residual waste
- Clusters partly reflected the urban vs. rural area dimension

The main purpose of the classification was to sort the sampled areas into groupings and to generalise composition for each of the main groups obtained. This exercise still made use of all of the samples, as these were reflected in mean waste composition for each group, but this approach had merit in reducing the overall influence of individual data points in producing district-level compositional estimates. Furthermore, as the relationship between collected waste and CA site waste was a basic dimension of the classification, it represented a more satisfactory means of extrapolating from individual samples than calculations based on ACORN profiles.

Although ACORN group was not found to be a particularly powerful indicator for explaining differences in total collected household waste arisings between the samples (even though it had been used as the basis of the sampling), it is important to look at socio-demographic influences

alongside CA site use and the mode of collection of refuse. CA site use is the factor more strongly related to the amounts of collected waste generated in an area, showing that in areas with high CA site use, the amount of household waste collected by the WCA/UA is significantly less, compared with areas with low CA site use. The design of future compositional analysis should take this into account.

6.4 Building an Integrated Compositional Analysis

The sampled compositional analysis when averaged over the clustered groups of similarly performing districts does smooth out some possible random variations in the individual data, but it is only a snapshot in time and as such is likely to reflect seasonal influences as well. This is especially the case where compositional sampling has been carried out in one season only, as it was in the case study. However even analyses sampled over several seasons still represent snapshots and can benefit from integration with other data. In order to minimise errors in the analysis it is important to reduce rather than compound likely compositional errors. This can be achieved by using where possible data averaged over whole districts and over a year, and to apply any compositional split to this data to break it down into material groups.

The method chosen to build an integrated compositional analysis for each district was therefore based on the approach of first applying the clustered group compositional analysis to each district's annual collected residual waste data, and then adding to this the annual kerbside recycling totals, HWRC and 'bring' site statistics. This combined data will thus give a better indication of total household waste composition for each district. The steps involved in this are outlined below in Figure 6.1.

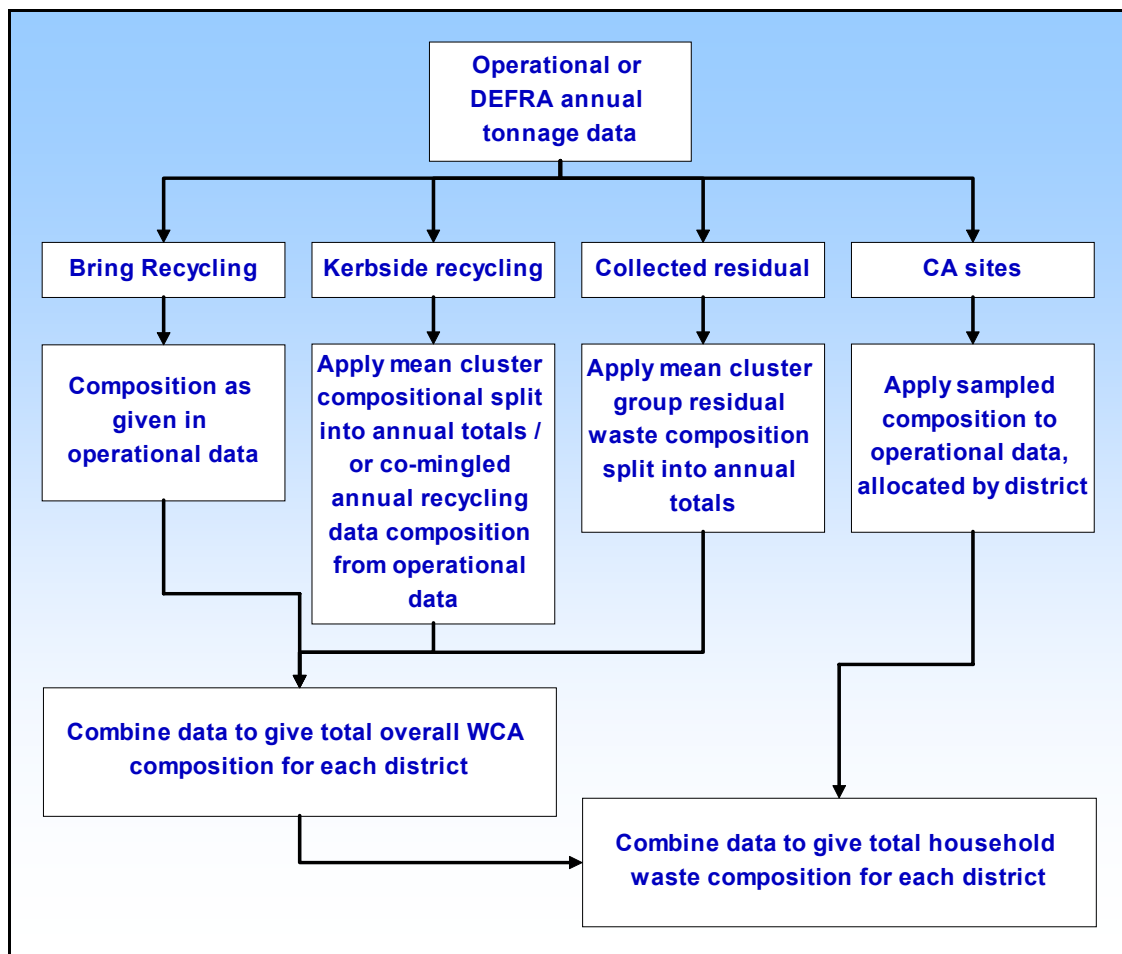


Figure 6.1 Reconstructing the waste stream

In order to combine different data with different compositional categories, the fairly simple grouping into 'glass; paper + card; dense plastics; cans; kitchen waste; garden waste; unclassified material and other; and other CA or HWRC recycled' was used in the case study. The other or unclassified category contains a wide range of materials, including materials not currently recycled in Hampshire such as plastics film, and metal foil, as well as a large proportion of HWRC residual waste which was of unknown composition due to the limitations of the compositional analysis.

Each waste stream was analysed differently:

1. Recyclables collected through bring sites are recorded in the operational data under a range of material classifications.
2. Kerbside recyclables are often recorded as one co-mingled figure in the annual operational and DEFRA data, and for Hampshire this was for paper + card, dense plastics and cans. In some cases DEFRA data on the proportions of each type of material was available; otherwise an average split can be used to give the amounts of each category of material present in the kerbside collected recyclables. Accuracy of this analysis of kerbside composition could be improved by using a compositional profile that more accurately reflects each district's collections. This aspect however is unlikely to affect overall the compositional analysis significantly, since kerbside collected recyclables account for only around 9% of total household waste in Hampshire compared with around 65% for collected household residual waste. Where compositional studies are available for kerbside recyclables collections as well as residual wastes, then clustered compositional averages for each area can be calculated in the same way as for residual collected wastes, and then applied to the annual, district data.
3. Residual collected waste was split into compositional categories by applying the mean cluster group compositions from the sampled residual waste data to the operational or DEFRA recorded annual total for each district.
4. To build a complete reconstructed household waste stream it is essential that CA site wastes are included in the compositional and quantity data. From the operational and sample data collected in Hampshire, it was possible to map total quantities of CA site/ HWRC waste collected onto each district. Sampled surveys at four sites gave an average composition analysis of the materials delivered to HWRCs, but one that included a category of 'small household' deemed to be similar to residual collected waste. This fraction was further disaggregated into component materials, assuming its composition to be the same as collected residual waste, and an overall compositional profile for each district's HWRC waste compiled.

The CA site data was now in a format that allowed it to be re-combined with the other waste streams of collected and bring site wastes to give a total household waste compositional profile for each district.

The recombination was done in two stages – first to produce a composition for each WCA of collected and bring site materials (shown in Table 6.4), and second for the total household waste stream including residual collected, kerbside recyclables, bring and CA site wastes for each district (shown in Table 6.5), and then for Hampshire as a whole (shown in Figure 6.2).

Insert 6.5 Hampshire case study – recombining household waste composition

Table 6.4 Composition of Hampshire WCAs collected household waste (residual, kerbside and bring)

	glass	paper & card	cans	dense plastics	textiles	garden waste	kitchen waste	unclassified & other
Basingstoke	7%	30%	6%	6%	5%	12%	16%	19%
East-Hampshire	7%	29%	6%	6%	5%	12%	17%	18%
Eastleigh	8%	35%	9%	6%	3%	2%	17%	20%
Fareham	5%	30%	7%	7%	3%	24%	12%	12%
Gosport	7%	29%	5%	6%	5%	10%	20%	18%
Hart	7%	26%	6%	7%	3%	26%	13%	13%
Havant	7%	30%	7%	7%	5%	9%	18%	17%
New-Forest	9%	33%	7%	6%	5%	9%	17%	15%
Rushmoor	7%	30%	5%	6%	5%	12%	17%	18%
Test-Valley	7%	25%	8%	6%	4%	16%	17%	17%
Winchester	7%	32%	6%	6%	5%	11%	15%	17%

Table 6.5 Composition of the Hampshire total household waste stream (residual, kerbside, bring and HWRC)

	glass	paper & card	cans	dense plastics	textiles	garden waste	kitchen waste	unclassified & other	other HWRC recycled (oil, batteries, wood + bric-a-brac)
Basingstoke	6%	26%	6%	5%	5%	17%	14%	19%	2%
East-Hampshire	6%	25%	6%	5%	5%	18%	14%	18%	2%
Eastleigh	6%	25%	8%	5%	3%	17%	12%	20%	5%
Fareham	5%	25%	7%	6%	3%	28%	10%	14%	3%
Gosport	5%	22%	6%	4%	4%	21%	14%	19%	4%
Hart	6%	24%	6%	6%	3%	28%	12%	14%	1%
Havant	6%	22%	7%	5%	4%	21%	13%	18%	4%
New-Forest	7%	25%	7%	4%	4%	18%	13%	17%	4%
Portsmouth	6%	29%	5%	5%	5%	17%	13%	18%	2%
Rushmoor	6%	22%	6%	4%	4%	23%	12%	19%	4%
Southampton	6%	31%	5%	5%	5%	16%	14%	18%	2%
Test-Valley	7%	22%	8%	5%	4%	21%	14%	17%	2%
Winchester	6%	27%	7%	5%	5%	18%	13%	18%	3%

Insert 6.5 Continued

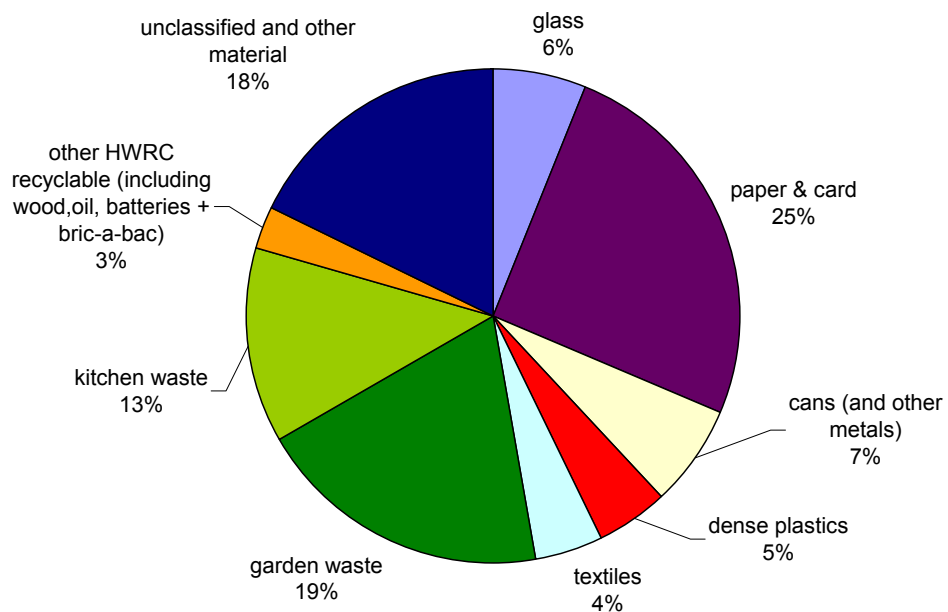


Figure 6.2 Overall composition of Hampshire's household waste (collected, HWRC and bring)

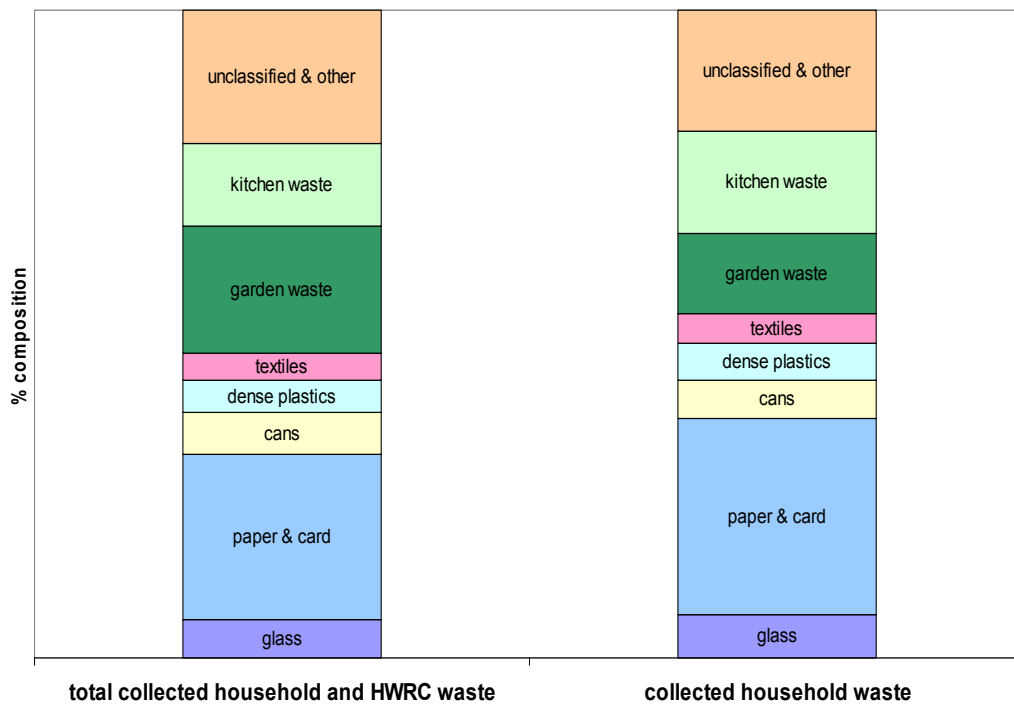


Table 6.6 Comparison of composition of Hampshire's total and collected household waste

The overall compositional profile for Hampshire's household waste based on these compositional profiles of districts is shown in Figure 6.2. The unclassified materials element contains mostly material that is currently not easily recycled and some of which would be categorised as unrecyclable – such as fines, plastic film and miscellaneous non-combustibles. However this unclassified element also includes some HWRC residual waste that may include materials from other categories, but which have been insufficiently analysed. More extensive data and analysis of HWRC composition would help to improve the accuracy of this overall compositional split.

Table 6.6 compares the compositional profiles for Hampshire of the total household waste including HWRC waste, with that for collected residual and kerbside recyclable waste only. This demonstrates significant differences in the proportions of different materials calculated to be in the waste stream, particularly for paper & card, and putrescible waste.

6.5 Summary and Conclusions

Public behaviour in relation to waste disposal and recycling varies significantly from area to area, but is generally not random and will depend on a number of factors. Perhaps the most important influential factor will be the infrastructure provided by the local authority for both waste and recycling collections as well as the provision of Civic Amenity and 'bring' sites for recycling (Parfitt *et al*, 2001). Other factors though will also affect behaviour including socio-economic and demographic influences (such as car ownership and household size) and issues related to attitude, understanding and motivation to adopt different types of behaviour. Looking at one aspect of the household waste stream independently of the others can build a misleading picture of the amount and type of waste produced by households in any particular area. It is essential therefore to integrate as far as possible the findings for the different outlets for households waste, particularly for CA sites and collected wastes through kerbside recycling and 'dustbin' residual waste collections, in relation to the different methods of waste containment and different 'waste catchment' characteristics. This should enable variations in compositional samples to be explained more clearly, both in terms of socio-economic and infrastructure differences between areas.

Knowing the composition of the total household waste stream has important applications in exploring strategic planning for waste management in a number of areas, including the potential for meeting the recycling targets and for infrastructure capacity. To evaluate how much material can be captured by different approaches to recycling requires not only realistic data on material diversion and participation rates achievable but also accurate knowledge of what material is potentially available in the waste stream.

Knowledge of the composition of all household waste arisings is important not only at a local level using locally derived data, but also for national strategic planning. This can be illustrated by drawing comparisons with the compositional analyses on which the national Waste Strategy for England and Wales (DETR, 2000) was based. Table 6.7 compares the compositional profile obtained from this study for the reconstructed waste stream (including the CA site waste) for Hampshire, with the national average composition used in the development of the national waste strategy. The latter was based on compositional profile generated by the NHWAP, which apart from only analysing collected waste composition, is now somewhat out of date being carried out in 1993. It has also been criticised for failing to adequately cover seasonal variations and for insufficient sampling of wheeled bin households (Parfitt and Flowerdew, 1997).

As Table 6.7 shows there is a wide discrepancy between the amount recorded as putrescible in these data sets, which has important implications for both meeting recycling targets and the requirements of the Landfill Directive. The proportion of biodegradable waste assumed in the

National Waste Strategy for England and Wales has already been questioned by many sources (House of Commons, 2001); a conclusion this research analysis supports.

Table 6.7 Comparison of Hampshire household waste composition with data in the 'Waste Strategy 2000'

Material category	Hampshire total household waste composition (%)	Hampshire average collected household waste composition	Municipal waste composition in 'Waste Strategy 2000' ¹ (%)
Paper/card	25	30	32
Putrescible	32	28	21
Textiles	4	5	2
Ferrous and non-ferrous metals	7	6	8
Glass	6	7	9
Dense plastics	5	6	6
Other	21	19	22

¹ DETR (2000)

Applying the same assumptions made in 'Waste Strategy 2000' for the proportions of different material categories that constitute biodegradable and recyclable fractions to the Hampshire total household waste compositional split gives some interesting comparisons. It produces similar recyclable fractions of 60% in 'Waste Strategy 2000' and 63% for the Hampshire data, but these are made up of different proportions of constituent recyclable materials. However the percentage of biodegradable waste calculated in this way for Hampshire is higher at 67% as compared to the 62% calculated 'Waste Strategy 2000', thus demonstrating how different compositional analysis can be if it only reflects collected 'dustbin' waste and not all household waste.

More recent and reliable data on national average household waste composition comes from the Strategy Unit report (Parfitt, 2002) which analyses 27 recent, available data sets to construct a best current estimate of a national household waste composition. For comparison purposes this analysis grouped authorities, whose compositional analyses were being studied, according to the 2 key factors that were felt to influence waste arisings: methods of refuse containment, and levels of recycling infrastructure. The study also analysed the full set statistically, based on these clusters and correlated to national DEFRA data and derived a national average composition. This study used the same basic methodology developed in this research and described in this Report, but with a different data set. Some of the findings of this analysis of national household waste composition were later adopted and used in the WET (Waste Emissions Trading) Bill, currently going through Parliament.

The Strategy Unit report provided national cluster compositional analyses separately for both collected and CA household waste for 29 material categories, as shown in Table 6.8, as well as an integrated composition for all household waste (collected and CA site) for a simplified classification of 9 material categories (shown in Table 6.9). The latter analysis is shown alongside the Hampshire compositional profile, for comparison. The Hampshire data differs mainly from that reported in the Strategy Unit report in that paper and card shows a higher proportion at 25% compared to 19%, and a significantly lower proportion of putrescible material at 32% compared to 42%.

Comparing these results with national average household waste composition, also incorporating CA site waste, from the Strategy Unit report shows similar proportions of

biodegradable and recyclable fractions. Again applying the assumptions made in 'Waste Strategy 2000' for the proportions of different material categories that constitute biodegradable and recyclable fractions for comparability, the Hampshire data gives a biodegradable fraction of 67% and recyclable fraction of 63%. This compares to the Strategy Unit's figure of 68% for both the biodegradable and recyclable fractions.

The Strategy Unit report also shows a similar shift in the amounts of paper & card and putrescible wastes when comparing composition of 'bin' or collected household wastes with total household wastes including CA sites. For paper & card the majority appears in 'bin' waste, with 199kg/household/year in this category and only 211kg/hh/y in total. For putrescible wastes though 338kg/hh/y are collected in 'bin waste, whereas 457kg/hh/y is found in total waste, resulting in comparative differences in overall percentage composition.

Some differences between the national average household waste composition and the results of this case study application of the compositional analysis methodology developed in this research will no doubt arise because the original sampled data for Hampshire on which the case study analysis is based is a single season study. For this reason it was not considered sufficiently reliable to be included in the national data set for the Strategy Unit study, and this consequently throws some doubt on how accurate a reflection the original sampled data in this case was of the overall annual composition of household waste. As explained in the description of the methodology developed in this research, the approach deals statistically with many potential inaccuracies and fluctuations in the sampled data, providing a way to smooth out some of these. However better baseline surveyed data would provide, using this methodology, a more accurate picture of total waste composition. There is an urgent need for national agreed protocols in waste composition studies, setting minimum requirements for data sets used for calculations of capture rates and other performance indicators. Without this guidance, which should be provided by DEFRA, local authorities are vulnerable to commissioning expensive but inadequate studies without this.

However nationally aggregated data also hides wide variations between authorities, some of which may be due to differences in infrastructure provision or socio-demographic factors, as measured by indicators such as the deprivation index, council tax banding, ACORN group etc. Likewise the average composition of household wastes in Hampshire also hides variations between districts and probably within districts. This can be seen by examining the data for collected 'dustbin' waste for different districts which shows widely varying compositions, and which reflect the different mix of collection infrastructure and policies in place.

This is very much the case for putrescible waste, and as can be seen from Table 6.4, the proportion of putrescible waste in collected household waste (not including CA site waste) varies from 19-39% in Hampshire. Eastleigh, which has the lowest figure of 19%, collects residual waste alternate weekly and consequently has very high CA site use. Another district with lower putrescible content in collected waste of 26% is New Forest which collects residual waste with plastic sacks, whereas Hart which freely accepts garden waste in their wheeled bin collections has 39% putrescible in their collected household waste.

The average composition for the reconstructed waste stream including CA site waste for authorities in Hampshire shows a higher proportion of putrescible waste, but significantly lower percentage of paper and card, compared with the composition of collected waste only. This indicates that a high proportion of household paper and card is in collected waste rather than CA site waste. The change in the relative percentage composition of the different constituents in the waste stream, when CA site waste is added in, is affected not only by the significant quantities of green waste concerned but also by the addition of a significant amount of other materials. This includes a larger unclassified category and needs further analysis to dis-aggregate this fraction to improve the reliability of the compositional split.

Table 6.8 Detailed results of Strategy Unit compositional analysis: England 2000/01

	'Bin Waste'	Civic Amenity Site Waste
Category	% wt	% wt
Newspapers & Magazines	8.1%	1.3%
Other recyclable paper	5.8%	0.9%
Liquid cartons	0.4%	0.0%
Board packaging	1.2%	1.6%
Card and paper packaging	3.5%	0.0%
Other card	0.2%	0.1%
Non-recyclable paper	3.5%	0.3%
Plastic Bottles	2.1%	0.1%
Other dense plastic packaging	2.1%	0.2%
Other dense plastic	0.6%	0.6%
Plastic film	4.0%	0.3%
Textiles	3.2%	2.0%
Glass bottles and jars	7.9%	1.2%
Other glass	0.5%	0.2%
Wood	2.7%	8.8%
Furniture	0.3%	4.6%
Disposable nappies	2.4%	0.0%
Other Miscellaneous combustibles	0.6%	2.3%
Miscellaneous non-combustibles	2.1%	15.0%
Metal cans & foil	3.4%	0.0%
Other non-ferrous metals	0.0%	0.1%
Scrap metal/white goods	2.9%	9.7%
Batteries	0.0%	0.2%
Engine oil	0.0%	0.1%
Garden waste	15.3%	37.6%
Soil & other organic waste	1.1%	11.3%
Kitchen waste	12.1%	0.3%
Non-home compostable kitchen waste	10.1%	0.0%
Fines	3.7%	0.9%
TOTAL	100%	100%

(Parfitt, 2002)

Table 6.9 Comparison of Hampshire household waste composition with data from the Strategy Unit report

Material category	SU report national composition (%) ¹	Material category	Hampshire total household waste composition (%)
Paper/card	19%	Paper/card	25%
Putrescible	42%	Putrescible	32%
Textiles	3%	Textiles	4%
Metals	7%	Ferrous and non-ferrous metals	7%
Glass	7%	Glass	6%
Plastics	7%	Dense plastics	5%
Misc. combustible	8%	Other	21%
Misc. non-combustible	4%		
Fines	3%		

¹(Parfitt, 2002)

By integrating operational data with sampled compositional analysis, it has been possible to derive a method for using the compositional data in a way that takes account of the relative use of CA sites and other 'bring' sites across Hampshire. From this a reconstructed household waste composition that takes account of all household waste arisings was produced. The importance of accurate compositional analyses of the whole household waste stream, and not just of collected 'dustbin' waste, should not be underestimated in waste strategy development, at both a local level and also for national strategic planning. Waste strategies based on an inaccurate picture of composition can easily be skewed in different directions by what the compositional analysis suggests is or is not feasible. An important implication of this analysis is that waste strategies should no longer be based on compositional analyses that only sample collected 'dustbin' waste.

Chapter 7 — Use of Scenarios in Strategy Planning

7.1 Introduction

Scenarios are often used in strategy planning to explore and compare different options for future waste management, and some examples of these were referred to in the strategy planning review detailed in Chapter 2. Scenarios range widely in detail, with some including only descriptive outlines of the different options suggested, perhaps with estimates as to how these options will perform against the authorities aims and objectives. Others might include full and detailed evaluation of each option's performance against recycling and other waste management targets, as well as evaluating the BPEO including environmental impact with LCI and other techniques, cost factors, risk aspects and their social and political implications. What form scenarios take and how they are used will depend on a number of factors, including the purpose for which the scenarios are being developed as well as the resources and data available to those developing them.

One dictionary definition of scenarios is 'an imagined sequence of events, especially any of several detailed plans or possibilities'. Scenarios are used, and constructed, in many different ways. Coates (2000) describes three uses of scenarios. They may be used to tell about some future state or condition and stimulate thinking about the future; or to display the consequences of particular choices and be used as a tool for explaining or exploring policy decisions or options; or alternatively used as illustrations to map a range of realistic future situations. In this research we used scenarios for both the latter two uses – scenarios were explored to illustrate the consequences of particular choices of recycling policy, and used to predict recycling performance resulting from particular policy choices.

Scenarios have been in popular in strategic planning since the 1980s, but scenario and strategy can get confused with each other. Scenarios can be used to clarify strategic options available, but only express some possible options that may exist. They should not be confused with being a choice of strategic options. "A scenario is not future reality, but a way of foreseeing the future" (Godet, 2000).

Scenarios are not an end in themselves but a tool for exploring policy decisions, and unless they are designed to illuminate a specific strategic decision then they may not help policy makers identify choices. They can be used for strategy development or strategy evaluation, including risk assessment. It is important that scenarios are credible to the user or recipient, and it helps in this respect if it is transparent about what the rules were for its construction. But they also need to be relevant, important, coherent and plausible (Godet, 2000).

The scenarios described in this Chapter are fairly specific in their focus and uses; scenarios can also be used to explore, through stakeholder involvement, broader issues where the multiple perspectives of different players need to be explored and balanced in policy and decision making. Both areas are relevant to waste management strategy planning, but this Chapter looks at building scenarios that can be used to explore the outcomes of policy choices on future performance and achieving specific performance targets, and considers the costs of these scenarios using a standard cost methodology.

To further explore how waste data can support strategic planning, the analysis of weight and composition data for the complete household waste stream for Hampshire was taken a step further and used to develop a series of scenarios. These were designed to explore how specific policy changes might perform towards meeting government BVPI recycling targets. The research started with a framework suggested by Hampshire CC that included improving the recycling infrastructure and achieving increased public participation. They explored enhanced

provision for bring, kerbside dry recycling and the introduction of green waste kerbside collections for composting as a means to meeting the government 2003 and 2005 targets for recycling.

To move from 'increasing bring site provision' or 'a communication campaign to increase public participation' or 'introduce kerbside collection of garden waste' to what recycling rate that might achieve, requires a number of assumptions to be made. In essence what these scenarios did was to:

- start with a plausible set of policy options, developed with the policy makers;
- develop assumptions from analysis of data on 'best practice' and other recorded experience; and
- take these assumptions and apply them to the best available data to work out what those recycling rates might be if the different policy options were implemented.

The scenarios focus around predicted capture rates that could be achieved by different developments in recycling provision. These capture rates were then applied in two different situations to assess and explore what could be achieved within each scenario.

In the first, described in Section 7.2, eleven scenarios were considered and applied at the Waste Disposal Authority (WDA) or County level (in the case study this was to the Project Integra authorities as a whole – covering the Hampshire WDA and the Unitary Authorities of Southampton and Portsmouth). This looked at a situation where waste growth was not factored into future projections, and the scenarios predicted overall recycling rates for each option.

The second, described in Section 7.3, explored each Waste Collection Authority's (in the case study this was the Hampshire district authorities) performance in greater detail, taking account of predicted waste growth and comparing results to BVPI targets faced by each WCA. Six of the scenarios developed in the previous work were explored. The recycling rate that each scenario would achieve was calculated and compared to that required in 2003 and 2005 to meet the government targets.

These scenarios are purely illustrative, showing how the targets could be met, and not necessarily how they should be met. They allow exploration of the implications of different policy options on the recycling rates that they might achieve.

7.2 Scenarios at WDA Level to Compare Options and their Overall Recycling Rates

The first set of scenarios explored in this research were applied at the WDA or County level – this being for the Project Integra authorities as a whole in the case study. They were based on assumptions made about capture rates that could be achieved for each recyclable material targeted given the policy choices included in each scenario. These capture rates were applied to a specific set of waste arisings and composition data for household waste – no account was taken of future predicted waste growth, as the scenarios were used to provide comparisons between what recycling rate each can achieve, rather than predicting future recycling rates for each. For the case study the data used was for the base year of 1998/9, and performance in this year was included as scenario 0 for comparison.

The scenarios applied to these data are summarised and listed in Table 7.1.

Table 7.1 summary of scenarios considered

Scenario	Main features and assumptions
Scenario 0: situation in 98/99	Status quo in Project Integra in 1998/9
Scenario 1: high bring for glass and textiles	Divert more waste (glass and textiles) through bring systems; assumes an increased capture through bring sites for glass and textiles to 60%
Scenario 2: improved kerbside collection of dry recyclables (paper, cans and dense plastics)	Increased capture rate of kerbside collections of paper, cans and dense plastics to a rate based on current best performance in the county
Scenario 2a: improved kerbside collection of dry recyclables – including glass	Increased capture rate of kerbside collections of paper, cans and dense plastics to a rate based on current best performance in the county; assumed capture rate for glass based on good practice in other authorities; glass taken to bring site reduced to 12% capture
Scenario 3: charged kerbside collection of garden waste – dry recycling remains the same	Collection of kerbside garden waste with a charge introduced; total waste collected remains the same – no diversion of green waste away from CA sites assumed in this scenario; assumes 25% of garden waste available in collected waste is captured
Scenario 4: free kerbside collection of garden waste – dry recycling remains the same	Introduce collection of garden waste at no charge, and assume 75% of this garden waste is captured for composting; assume that this will attract 50% more garden waste into collected waste total, and assume 50% of this increase is diverted from CA sites + 50% is increased waste generated, such as diverted from home composting; assume dry recycling remains the same
Scenario 5: improved targeting of bring and kerbside – high diversion dry recycling 1	Combining the effects of scenarios 1 + 2; increased capture rate of kerbside collections of paper, cans and dense plastics to a rate based on current best performance in the county; increase capture through bring sites for glass and textiles to 60%
Scenario 6: improved targeting of bring and kerbside with charged garden waste collection – high diversion recycling 2	Combining the effects of scenarios 1 + 2 + 3; increased capture rate of kerbside collections of paper, cans and dense plastics to a rate based on current best performance in the county; increase capture through bring sites for glass and textiles to 60%; 25% of garden waste available in collected waste is captured by introducing collection of garden waste at a charge; total waste remains the same – no diversion from CA sites
Scenario 7: improved targeting of bring and kerbside with free green waste collection – high diversion recycling 3	Increased capture rate of kerbside collections of paper, cans and dense plastics to a rate based on current best performance in the county; increase capture through bring sites for glass and textiles to 60%; 75% of garden waste in collected waste captured; garden waste in collected waste increases by 50%; assume 50% of this is diverted from CA sites + 50% is increased waste generated
Scenario 8: improved targeting of bring and kerbside with free organics collection of garden +kitchen waste – high diversion recycling 4	Increased capture rate of kerbside collections of paper, cans and dense plastics to a rate based on current best performance in the county; increase capture through bring sites for glass and textiles to 60%; 75% of garden waste in collected waste captured; garden waste in collected waste increases by 50%; assume 50% of this is diverted from CA sites + 50% is increased waste generated; kitchen waste capture of 21% assumed

Scenario 9: capture rates taken from "Maximising Recycling Rates" Community Recycling Network Report ¹	Maximise kerbside collection of dry and organic recyclables; maximise CA site recycling; capture rates represent best practice in Europe – as cited in Hogg and Mansell, 2002
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¹ Hogg and Mansell, 2002

The capture rates assumed in the scenarios could be based on any experience of 'best practice' for the types of schemes being considered. Scenario 9 took a very wide view of this and used data from the Community Recycling Network (CRN) report "Maximising Recycling Rates" (Hogg and Mansell, 2002) to consider what many may consider an extreme 'high recycling' scenario but one that is based on selected experience in Europe. Most of the scenarios used in the case study, and described above, used capture rates based on current 'best' practice in Hampshire. These were taken from the 5 best rounds that were sampled for waste analysis, and compared with other data on capture and recycling rates (Project Integra, 1999; Milton Keynes Council, 2000; Hogg and Mansell, 2002; FOE and CRN, 2001; and Mansell, 2001).

Each overall material capture rate is a function of service provision (i.e. % households served by kerbside), public participation and the proportion of the target material captured by the scheme from participating households. The assignment of participation rates and scheme capture rates to produce overall district material capture rates is arbitrary as it is up to each district how material capture rates are achieved (high participation and high material recognition can only be achieved through extensive communication campaigns). Analysis of the research sampled round data in Hampshire showed the 'best' performing kerbside round to be achieving an overall capture rate of targeted materials of 63%, with a capture rate for paper and card of 75%.

Assumptions about individual capture rates for different recyclable materials and for different types of recycling collection scheme does not take account of interactions that might occur between these. For instance material may be diverted from one stream to another, or the focus on increasing one aspect of recycling behaviour could have spin-offs in other areas. The scenarios do consider some aspects of green waste being diverted into the collected waste stream by the introduction of kerbside collections, either from CA sites or home composting. The assumptions developed here are explained in more detail below in Section 7.2.1.

7.2.1 Allocation of 'green waste' to recycling scenarios

Assumptions need to be made about where the green waste collected by introducing kerbside collections of garden or green waste comes from. Green waste collections refer to the putrescible element of household waste, and although mostly indicate garden waste collection only, they do not exclude the option of collecting both garden and kitchen wastes (as explored in scenarios 8 and 9).

It was assumed in the scenarios that 'charged' green waste collections would not have a significant effect on changing public behaviour, but that where scenarios consider high diversion of garden or green waste by kerbside collection some diversion from other sources should be expected. Experience has shown that introduction of free kerbside collection of green waste has led to an overall increase in household waste collected (Parfitt, 2002). It was assumed in these scenarios that this was either diverted material previously taken by the householder to a CA site, or that it was new material to the household waste stream that was previously home composted, just left in the garden, or taken away by commercial contractors.

The assumptions made in scenarios 4, 7 and 8 which include free kerbside collection of green waste, are detailed in Table 7.1. They are based on very generalised assumptions that need further research to refine and produce more accurate predictions based on specific, actual experience. The case study Insert 7.1 below shows some of the data from which these assumptions were drawn.

Insert 7.1: Hampshire case study – green waste assumptions

Table 7.2 below shows the extra source material that may potentially be available if householders take less 'green waste' to their local HWRC when kerbside green waste collections are offered. In districts such as Eastleigh, the proportion of total organic waste taken by householders to HWRC is high.

However, not all of the material taken to CA sites would be suitable for kerbside collection (larger items of garden waste and grass clippings that exceed the capacity of the containment provided). Further analysis of CA site compositional data is required before the scenarios can be refined to take accurate account of this based on specific local data. Compositional analysis of Milton Keynes CA site waste indicated that about 40% of garden waste taken to CA sites could be classified as 'large' needing shredding before composting, and as such was unlikely to be suited to kerbside collection (MKC, 2000).

Table 7.2 Location of total organic fraction of household waste for WCAs in Hampshire 1998 /99

WCA	HWRC green waste recycling	WCA collected mixed organic waste	% total organic waste currently at HWRC
Winchester	2,491	10,819	19%
Test-Valley	2,225	14,376	13%
Rushmoor	3,498	8,462	29%
New-Forest	8,285	14,473	36%
Havant	5,004	10,873	32%
Hart	1,293	13,111	9%
Gosport	2,866	7,191	29%
Fareham	3,272	14,254	19%
Eastleigh	5,512	6,748	45%
East-Hampshire	2,609	12,320	17%
Basingstoke	2,934	15,843	16%
Total	39,990	128,469	24%

7.2.2 Recycling rates achieved by scenarios

The scenarios were used to explore the BVPI recycling rates that each would achieve. At the heart of 'best value' is the statutory performance management framework, and the best value performance indicators. This provides for annual reporting by best value authorities against a set of national performance indicators and standards set by the Government. Targets set for authorities are for combined recycling and composting rates – although they are often referred to just as recycling rates. They are defined as:

- Recycling rate = tonnage of household waste recycled by the authority / total tonnage of household waste collected by the authority
- Composting rate = tonnage of household waste composted by the authority / total tonnage of household waste collected by the authority

Insert 7.2: Hampshire case study – scenario recycling rates

Table 7.3 Recycling rates predicted for each scenarios for Project Integra

Scenario	diversion from disposal (recycling + composting rate)	recycling rate	composting rate
Scenario 0: situation in 98/9	19%	13%	6%
Scenario 1: high bring for glass and textiles	22%	16%	6%
Scenario 2: improved kerbside collection of dry recyclables (paper, cans and dense plastics)	30%	23%	6%
Scenario 2a: improved kerbside collection of dry recyclables - including glass	31%	25%	6%
Scenario 3: charged kerbside collection of garden waste; dry recycling remains the same	21%	13%	8%
Scenario 4: free kerbside collection of garden waste; dry recycling remains the same	27%	13%	14%
Scenario 5: improved targeting of bring and kerbside - high diversion dry recycling 1	33%	26%	6%
Scenario 6: improved targeting of bring and kerbside with charged garden waste collection - high diversion recycling 2	35%	26%	8%
Scenario 7: improved targeting of bring and kerbside with free green waste collection - high diversion recycling 3	40%	26%	14%
Scenario 8: improved targeting of bring and kerbside with free organics collection of garden +kitchen waste - high diversion recycling 4	42%	26%	17%
Scenario 9: taken from "Maximising Recycling Rates" Community Recycling Network report	62%	35%	27%

How do these compare to Hampshire's targets for recycling? There is no overall target for Project Integra (Hampshire CC recycling rate in 1998/9 was 23% without the performance of the two Unitary Authorities included, and that for PI with the UAs included is shown above as

19%) – but that for Hampshire CC is 33% for 2003/4 and 40% for 2005/6; and for Southampton 16% and 24%; and Portsmouth 24% and 36%.

Table 7.3 above shows that only scenarios 7, 8 and 9 achieve recycling rates at or above 40%; with scenarios 2, 5, 6 and 7 all achieving over 30%. All except scenarios 1 and 3 would achieve the national 2005 target of 25%.

Improved provision of kerbside dry recycling and the introduction of free green waste collection have the most impact on improving recycling rates. It is unlikely that the highest rates will be achieved without a combination of several policy approaches.

What recycling rate each scenario predicts will depend on the starting point of each authority. Hampshire started from an overall county recycling rate of 23% or of 19% for the Project Integra area, with strong input from kerbside collection of dry recyclables. As the scenarios adjust only certain elements of the waste management system, then the results for an area starting from a very different baseline may show different relative changes due to each scenario.

The results of the calculations for each scenario's predicted recycling rate for the case study are summarised in Insert 7.2.

Specific recycling and composting rates predicted as achievable for each scenario will obviously differ from authority to authority, as the data on existing practice, waste arisings and composition and achievable capture rates could differ. However some trends will be common to different areas. Application of scenarios to the case-study highlights some trends and overall issues. In general bring site recycling alone is unlikely to achieve longer-term national targets for recycling – 30% by 2010 or 33% by 2015. Effective kerbside collection of dry recyclables, achieving high capture rates, can reach or come close to these targets, and combining this with either improved bring provision or kerbside collection of garden waste meets the targets more easily. Introducing green waste collections without improved kerbside of dry recyclables is unlikely to reach the targets alone.

To really explore local variations and how to achieve the capture rates needed to be achieved requires closer examination of the results of each scenario to compare how each one achieves its overall recycling rate. Choices between options will not only depend on overall recycling rate achieved, but on many other factors including the environmental impacts of different choices and the specific priorities of policy makers. For instance if reducing biodegradable waste going to landfill is highest priority then scenario 4 will achieve a higher composting rate than scenario 2 even though the overall recycling rate for the latter is higher.

The highest diversion scenario was based on the data in the Community Recycling Network's report 'Maximising Recycling Rates'. This report considered best practice in the UK, and then assumptions about improvements which went beyond this, arriving at an overall recycling rate of 62% that they considered to be achievable for England (Hogg and Mansell, 2002).

7.3 Scenarios at WCA Level to Explore Meeting BVPI Targets

Some of the scenarios described in Section 7.2 were then applied to the individual district's waste data to explore how these might meet the government 2003 and 2005 targets for recycling for these WCAs. These detailed collected waste data and recycling rates, but not CA site wastes which are the responsibility of the WDAs. The scenarios explored for each district were scenarios 1-6 (but not including 2a), which included the introduction, extension or improvement of bring, kerbside dry recycling and green waste collection for composting (either charged or provided free). Each of these measures was first considered separately, in combined scenarios. The assumptions made in each scenario were mostly as listed in Table 7.1 above, with a few modifications to take account of differences between individual district's circumstances.

Because these scenarios are for specific WCAs within the WDA area, account can be taken in predicting 'best case' capture rates of local circumstances. The 'best case' for the area as a whole or from other experience may not be relevant in the time frame concerned if the WCA is starting from very low current performance; or it may be exceeded if the authority's current performance is already 'best case'. In this way the scenarios are based as much as possible on what is in place in each local area and on current 'best' practice within the WDA area, to be realistic within current performance.

These scenarios take account of predicted waste growth, and are designed to provide recycling rate performance comparisons with the BVPI targets faced by each WCA. Waste growth could be assessed in a number of ways, and in the case study data provided by the authorities themselves for future predictions was used. Details of these modifications and assumptions about waste growth and how they were applied in the Hampshire case study are given in Insert 7.3

Again these scenarios are purely illustrative, showing how the targets could be met, and not necessarily how they should be met. The recycling rate that each scenario would achieve was calculated and compared to that required in 2003 and 2005 to meet the government targets. Also recorded was the tonnage of recycled material that each scenario would achieve, and this compared to that required to meet the targets, giving a figure for any shortfall or overshoot in performance. They calculate the amounts that need to be collected and capture rates required for different recyclable materials in order to meet the targets.

The scenarios allow exploration of the implications of different policy options on the recycling rates that they might achieve. An initial question asked in the case study was to what degree can extension & improvement of dry recyclables kerbside be used to meet 2003/4 & 2005/6 targets? The scenarios can be used to predict the recycling rates achieved assuming specific capture rates, or the capture rates needed to achieve specific target recycling rates. The latter was calculated for each district in the case study and the results examined with a view to whether these capture rates were achievable. The results of this are described in Insert 7.4

Insert 7.3: Hampshire case study – WCA scenarios for predicting BVPI performance

Applying data about waste arisings and composition of the whole collected household waste stream to a district's Waste Volume Service Plan (WVSP) data enabled a series of scenarios to be explored towards meeting government's BVPI recycling targets for Hampshire.

Hampshire's operational data and predicted waste arisings are summarised in the WVSP, and this data together with the integrated compositional analysis previously developed was used in the scenarios. WVSP data was used to account for predicted increases in waste arisings and current projected recycling performance based on planned or anticipated changes in provision. The scenarios explored ways of improving and exceeding the predictions of the WVSP in order to meet the targets.

The calculations were done on the following basis:

- use the DEFRA base data for waste arisings in 1998/99 for each district, and include assumptions about the rate of growth in household numbers and in household waste from the WVSP
- based on compositional analyses developed in Chapter 6
- capture rates for different recycled materials based on what is currently achieved in that WCA (see Table 7.4) and what is the current best case in Hampshire
- apply assumptions about overall maximum material diversion rate that can be achieved by kerbside/bring schemes & materials targeted by kerbside/bring
- generate scenarios for each WCA for achieving the 2003 and 2005 targets

The assumptions made in the scenarios 1-6 used in this exercise were mostly as listed in Table 7.1 above, with a few modifications to take account of differences between individual districts circumstances:

- scenario 1: as in Table 7.1;
- scenario 2: as in Table 7.1 – but the increased diversion rates of kerbside collections to a rate based on current best performance in Hampshire is adjusted depending on what diversion rate the WCA is starting from; where current performance is low the is adjusted down, but where current best practice is already achieved a higher rate is assumed;
- scenario 3: as in Table 7.1;
- scenario 4: as in Table 7.1 – but Eastleigh is a special case in this scenario as it currently collects very little garden waste and generates high levels of HWRC waste – hence it is assumed that the amount of garden waste in the collected waste stream for Eastleigh will treble in this scenario;
- scenario 5: as in Table 7.1;
- scenario 6: as in Table 7.1;
- the results of the scenario building were provided in spreadsheet format in Excel files, one for each WCA.

Insert 7.4: Hampshire case study – capture rates required to meet BVPI recycling rates by scenario 2

The chart below shows the combined capture rates for kerbside target materials that are required to achieve 2003/4 & 2005/6 rates for each authority:

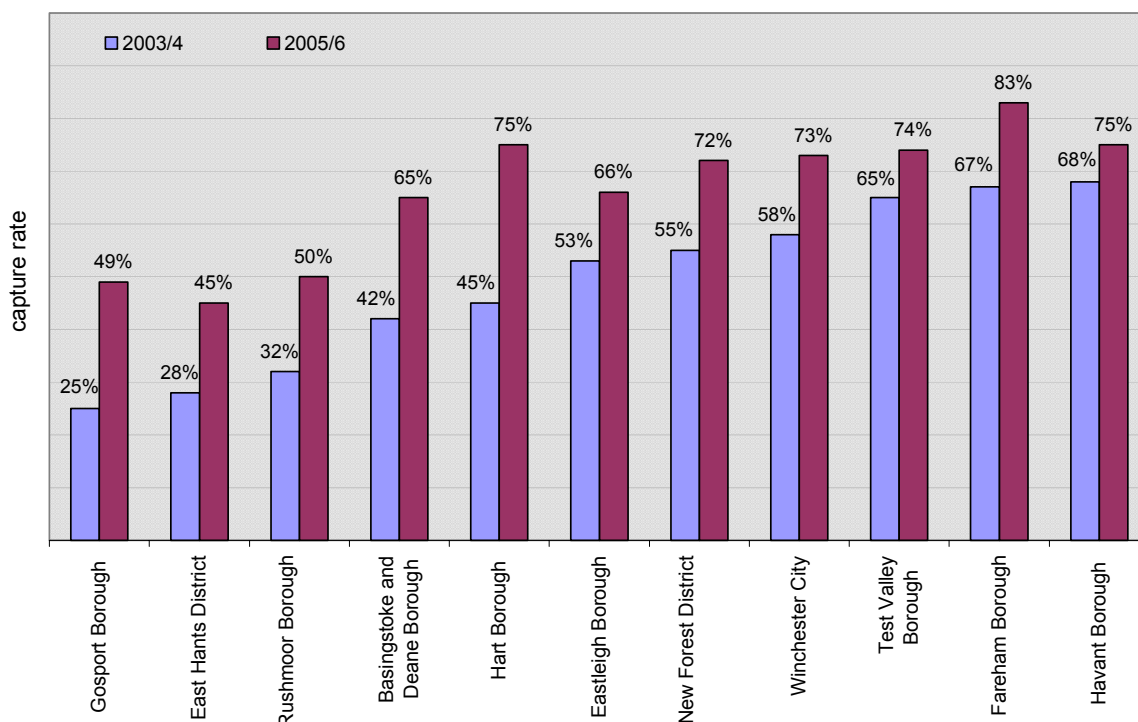


Figure 7.1 Scenario 2: 'dry' recyclables capture rates required from kerbside schemes to meet 2003/4 & 2005/6 targets (without bring site improvements (Scenario 1) & without targeting green waste (Scenarios 3 &4)

They are the results of scenario 2 where the capture rates (participation, recognition) have been set so that the recycling targets are met by dry recyclable kerbside alone. In most districts the material capture rates look perfectly achievable for 2003/4, although it can be seen by comparison with Table 5.1 that several districts will have to improve on current practice; but some will need green waste collections as well if 2005 targets are to be met. For comparison, Table 7.4 below shows the overall kerbside recycling capture rates for Hampshire WCAs in 2000/1:

Table 7.4 2000/01 Kerbside recycling capture rates for Hampshire

WCA	Capture rate for dry recyclables
Gosport	11%
East-Hampshire	26%
Rushmoor	9%
Basingstoke	19%
Hart	24%
Eastleigh	50%
New-Forest	33%
Winchester	26%
Test-Valley	17%
Fareham	41%
Havant	28%

Predicting the overall recycling rates for each WCA and for each scenario for the target years of 2003/4 and 2005/6 was the primary aim of developing these scenarios. They were designed to take account of specific local data on waste arisings and composition, and with this data can be applied to any WCA area. The results of applying these scenarios to the case study are summarised in the following tables and charts, and their implications for strategy development discussed in Insert 7.5.

In the case study, scenario 1 which considered the effects of improving capture of recyclables through bring sites alone failed in most cases to meet either 2003 or 2005 targets, although extra bring provision is shown to contribute to improved recycling rates. Scenario 2 showed that for most districts target recycling rates look achievable for 2003/4 by extending & improving dry recyclables kerbside collections, with only two WCAs needing to exceed current best practice in Hampshire for kerbside dry recycling to meet these. Most districts will need green waste collections as well as effective dry recyclables kerbside if 2005 targets are to be met.

The implications of green waste collections explored in scenarios 3 and 4 presents a more complex situation due to the unpredictable nature of the effects of introducing kerbside collection of green waste on material currently either composted at home or taken to CA sites. Not all of the material taken to CA sites would be suitable for kerbside collection (larger items of garden waste and grass clippings that exceed the capacity of the containment provided). Further analysis of CA site compositional data is required to enable the scenarios to be refined to account more realistically for the implications of green waste collections.

Insert 7.5: Hampshire case study – some results from the WCA scenarios

Table 7.5 below shows the tonnages required to achieve the 2003/4 & 2005/6 targets for each authority. This information was explored using the scenarios as it has implications for Project Integra in order to assess MRF capacity implications.

Table 7.6 gives a summary of the recycling rates achieved by each scenario for each district for the BVPI target years, and compares these with the BVPI target set for each authority.

The main points that emerge are:

- 2003 targets can mostly be met by kerbside recycling alone, with most WCAs not needing to achieve current Hampshire best practice in order to do so. Only Havant, Fareham and Test Valley would need to meet or exceed 65% capture rate to meet their 2003 targets, and hence might need to consider green waste collections for example. (Test Valley is a special case here in that it already operates a kerbside green waste collection which was not accounted for in this dry recyclables kerbside scenario, and which if included would reduce the capture rate required by Test Valley to meet its targets.)
- 2005 targets for most WCAs cannot be met without achieving very high capture rates, mostly above current best practice, and that they will need to consider kerbside green waste collection to meet their targets. The exceptions are Gosport, East Hants and Rushmoor.

Recycling rates for Hampshire Districts predicted by Scenarios 1-6

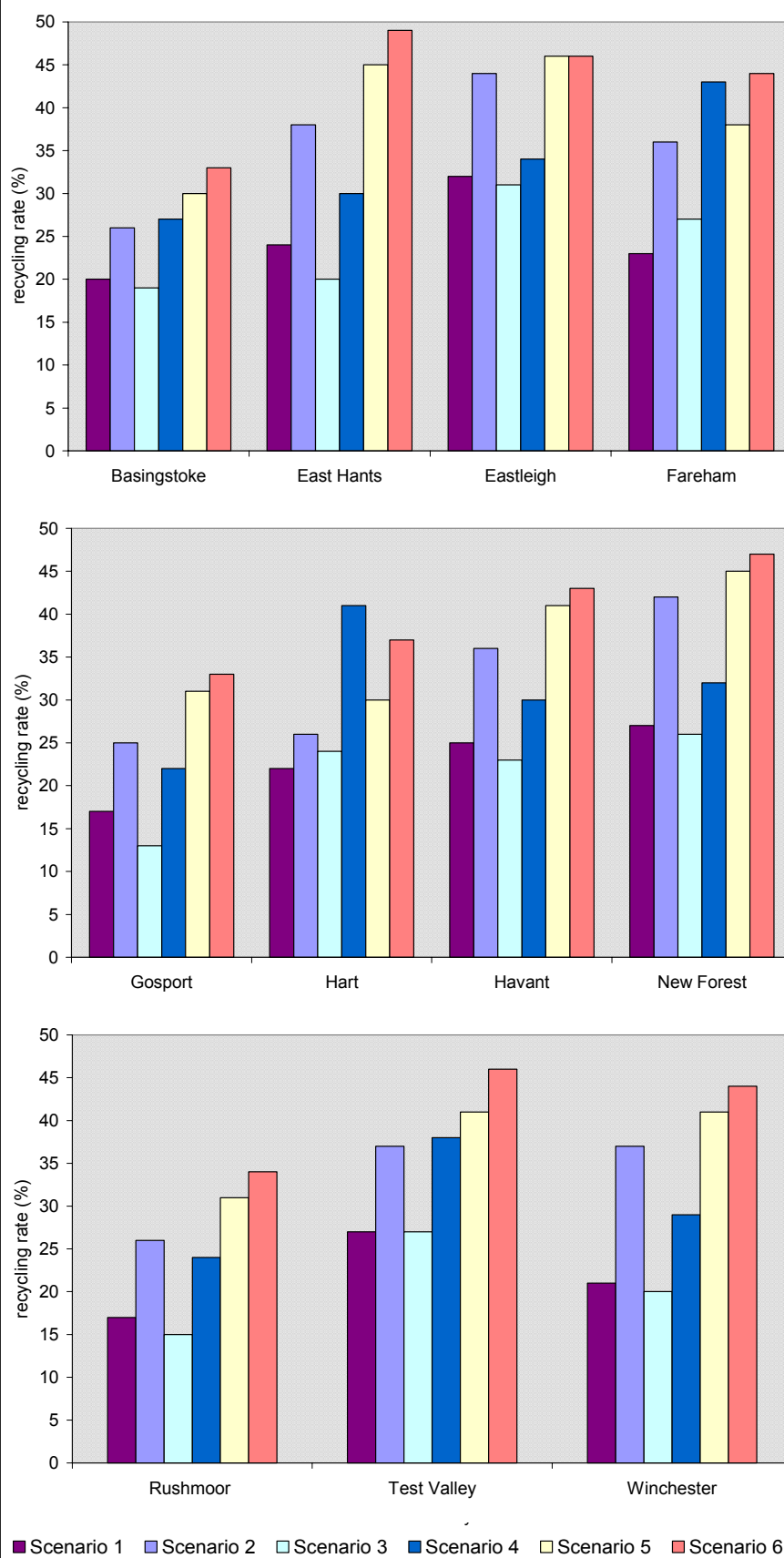


Table 7.5 Total quantities of material collected for recycling required under Scenario 2 (improved kerbside collection of dry recyclables) to meet 2003/4 & 2005/6 BVPI recycling targets

Authority	Eastleigh Borough		Fareham Borough		Gosport Borough		Rushmoor Borough		Hart Borough		Havant Borough	
Year	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6
WVSP bring recycling (tonnes/a)	2,400	2,600	1,700	1,800	2,500	2,700	1,200	1,200	1,400	1,500	1,700	1,800
WVSP kerbside + additional from improved kerbside (tonnes/a)	10,700	14,000	13,800	18,500	3,100	7,600	4,400	7,200	7,000	12,100	13,200	15,200
Recycling rate achieved by scenario (%)	39	44	32	36	22	25	22	26	22	26	32	36
Total recycling required to meet targets (tonnes/a)	13,100	16,600	15,500	20,300	5,600	10,300	5,600	8,400	8,400	13,600	14,900	17,000
BVPI targets set (%)	33	40	33	40	18	27	16	24	22	33	33	36

Authority	East Hants District		New Forest District		Winchester City		Test Valley Borough		Basingstoke & Deane Borough	
Year	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6
WVSP bring (tonnes/a)	1,300	1,300	5,500	5,600	1,900	2,000	2,700	2,800	2,300	2,500
WVSP kerbside + additional from improved kerbside (tonnes/a)	5,700	9,400	17,400	24,000	12,500	16,700	15,800	18,600	13,000	21,700
Recycling rate achieved by scenario (%)	34	38	37	42	33	37	33	37	21%	26%
Total recycling required to meet targets (tonnes/a)	7,000	10,700	22,900	29,600	14,400	18,700	18,500	21,400	15,300	24,200
BVPI targets set (%)	16	24	33	40	30	36	33	36	20	30

Table 7.6 Recycling rates (%) achieved by scenarios 1- 6 for each district in Hampshire

Authority	Eastleigh Borough		Fareham Borough		Gosport Borough		Rushmoor Borough		Hart Borough		Havant Borough	
Year	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6
Scenario 1	32	32	23	23	15	17	17	17	22	22	24	25
Scenario 2	39	44	32	36	22	25	22	26	22	26	32	36
Scenario 3	31	31	27	27	13	13	15	15	24	24	22	23
Scenario 4	34	34	43	43	21	22	24	24	41	41	28	30
Scenario 5	41	46	34	38	28	31	27	31	27	30	36	41
Scenario 6	41	46	40	44	30	33	30	34	33	37	39	43
BVPI targets set (%)	33	40	33	40	18	27	16	24	22	33	33	36

Authority	East Hants District		New Forest District		Winchester City		Test Valley Borough		Basingstoke & Deane Borough	
Year	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6	2003/4	2005/6
Scenario 1	24	24	27	27	22	21	27	27	21	20
Scenario 2	34	38	37	42	33	37	33	37	21	26
Scenario 3	20	20	27	26	21	20	27	27	20	19
Scenario 4	31	30	33	32	29	29	39	38	28	27
Scenario 5	41	45	41	45	37	41	37	41	26	30
Scenario 6	44	49	43	47	40	44	41	46	29	33
BVPI targets set (%)	16	24	33	40	30	36	33	36	20	30

7.4 Standardised Costs for Assessing Recycling Collection Options under the Different Scenarios

Cost plays a critical role for local authorities in assessing different options in their waste strategy planning. However, to do so, they need comparable information on the costs and performance of different collection systems. Without this it is difficult for local authorities to implement cost-effective recycling strategies to achieve their performance targets.

A method based on standard costs has been developed to overcome the problems associated with compiling comparable data on the financial costs for collecting refuse and recyclables from household waste (Hummel, 2002). Using data gathered from a selected sample of collection programmes the impact of the internal and external factors influencing the performance of recycling programmes have been analysed. The link between the performance of refuse and recyclables collections operating in the same environment was then examined to identify if this could be used as a basis on which to project realistic costs for the collection of household recyclables.

Using the results of the analysis a predictive methodology has been developed that can be used to project the costs of a range of collection systems in a standardised way. This approach for projecting refuse and kerbside collection costs enables the most cost effective systems to be identified locally, and has been used here as an illustrative example to consider the relative costs of each scenario for a collection authority in Hampshire.

7.4.1 *Information available on costs of recycling collection*

Hummel (2002) reviewed a range of studies on the costs of kerbside recycling, and quotes individual studies of schemes reporting widely divergent costs from as little as £18/tonne to £145/tonne. Both the Department for the Environment, Transport and the Regions (DETR now DEFRA) and the Audit Commission carried out surveys in 1996 in an attempt to clarify this issue (DETR, 1997 and Audit Commission, 1996). The DETR survey concluded that the net cost of kerbside collection ranged from £13 to £69 per tonne and the net costs for bring collection systems ranged from a surplus of £5 to a cost of £123 per tonne (this included collection costs and any processing (MRF) costs). The results of the Audit Commission survey, which was more extensive and included collection costs only, reported gross costs for kerbside collection ranging from £41 to £290 per tonne and for bring collections between £13 and £97 per tonne. The most recent survey carried out for Waste Watch by Ecotec, reported that household recycling costs range from £85 to £240 per tonne (Ecotec, 2000).

The conclusions from these surveys are primarily qualitative and the wide ranges in the costs provide no help for individual local authorities in estimating the costs of implementing alternative collection systems in their own WCA.

7.4.2 *Standardising collection costs*

From the studies that have been carried out it is clear that surveys of current costs of kerbside recycling systems cannot provide much of a guide to the possible costs of systems implemented in another district nor a basis from which to project the future costs of systems collecting a wider range of materials. A different approach, in which the costs of the different systems are standardised, has been developed to provide a method to compare the costs of different systems (Hummel, 2002).

The standard cost approach involves applying standard unit costs to infrastructure variables, for example the collection vehicles and operators, therefore operational data are required from the collection systems to be analysed. Capital costs are depreciated according to standard accounting rules. In this way comparable costs are established for the different systems.

Analysis of the standard costs shows that there are some trends in the collection costs for kerbside collections currently operating. However, more detailed analysis shows that the differences in the operation (e.g. collection frequency, extent of kerbside sort, type of vehicle), the household behaviour (e.g. participation, set-out) and the materials targeted make it impossible to use the information to project the future costs of well-established efficient collection systems such as those required to collect the increased quantities envisaged under Best Value.

7.4.3 Modelling collection costs for meeting BVPI targets

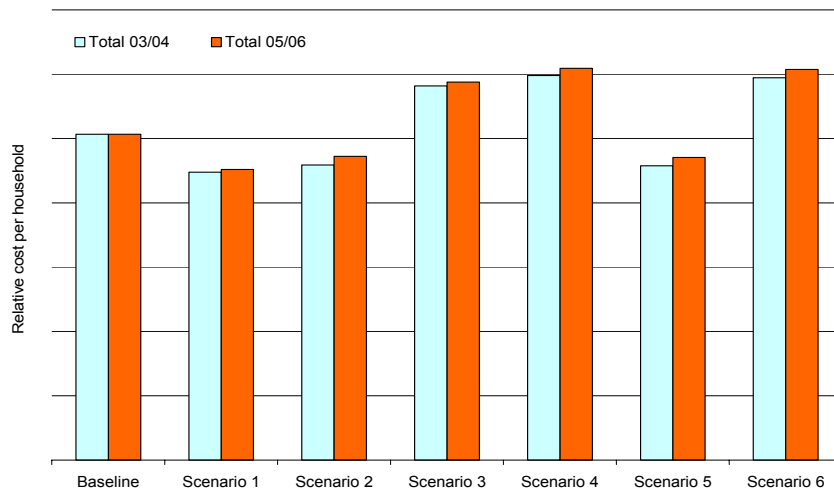
Building on the standard collection cost analysis approach a model was developed to enable standard kerbside and related refuse collection costs to be projected for every WCA in England in Wales (Hummel, 2002). The projections are based on the existing refuse collection infrastructure and take account of the local operating environment. The model includes all the variables influencing the collection, for example, the number of households served, distances driven by the collection vehicles, tonnages and type of material collected, size and type of collection vehicle, and unit financial values for all the capital items and operating costs.

To validate the model the costs of refuse collection were projected for the UK and compared to annual budgetary values published by the Treasury and to estimates provided by the waste management industry. The model was used to demonstrate the potential range in costs, and cost effectiveness, depending on how WCAs decide to recycle towards meeting their BVPI targets (Hummel, 2002)

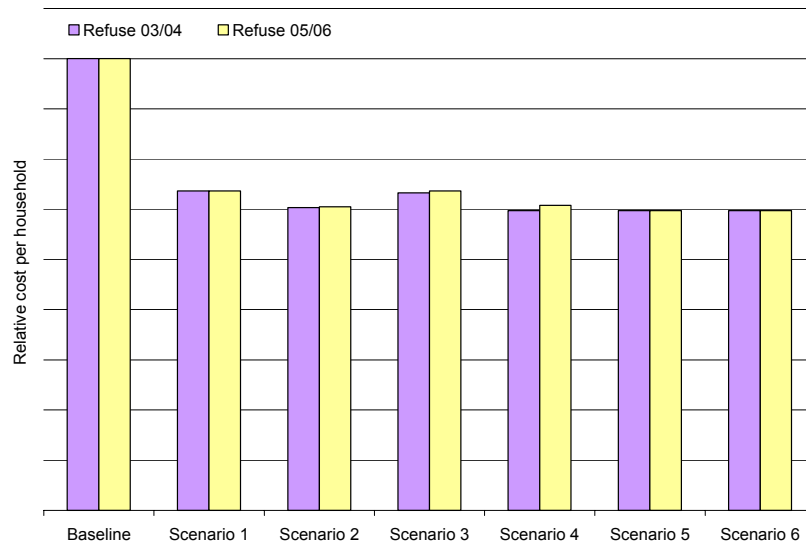
The model can be applied to compare standardised costs across a number of authorities for the same recycling collection approach, or to compare different schemes in a standardised costing way for the same authority. The former can be used to explore issues of cost effectiveness, in that where all infrastructure and costs have been standardised variation will reflect differences in cost effectiveness achieved by different WCAs. This approach was described in Hummel (2002) to demonstrate how standard costs can be calculated for every WCA in England and Wales meeting their own specific targets, assuming a similar approach to delivering recycling collection. This analysis showed a wide variation in the cost effectiveness across the WCAs, with the collection of recyclables in some WCAs achieved at a much lower average cost than in others (Hummel, 2002). The results suggest that some WCAs could achieve 40% of household collected waste recycling for the same, or even less, than it would cost others to only achieve 18%.

Comparison of different schemes within one authority was the approach explored in the case study research, and it is the relative costs that are of primary importance in this analysis. Because of limitations in available, accurate, local data the results shown in Insert 7.6 are for illustrative purposes only and the costs themselves are not included. The analysis could be refined to produce a more accurate representation of costs likely for the authority studied, provided detailed and more locally relevant data is available for this. With further analysis of these costs at the level of each individual authority it would be possible to evaluate the most cost effective collection system at a particular level of recycling and the conditions necessary to achieve it. The projections are for *collection* only and any additional MRF sorting or other processing must be added to these costs before drawing conclusions on the relative total costs of the different scenarios.

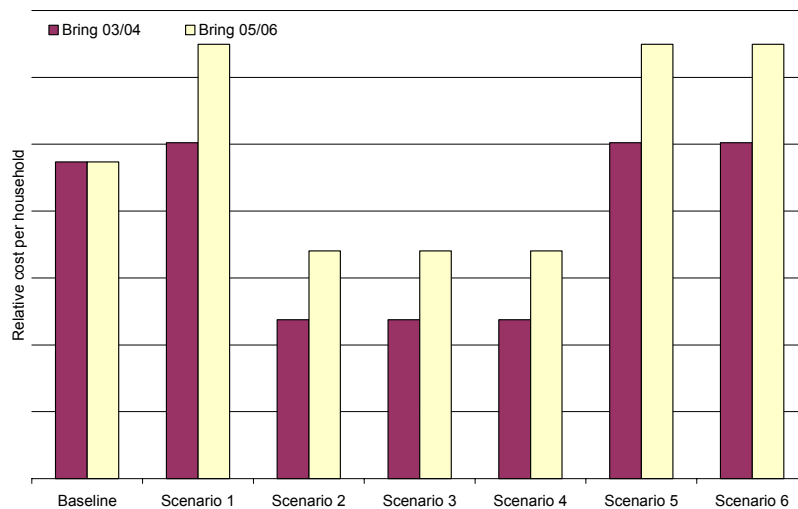
Insert 7.6: Hampshire case study – preliminary illustrative standard collection cost projections for the scenarios to meet Fareham's BVPIs



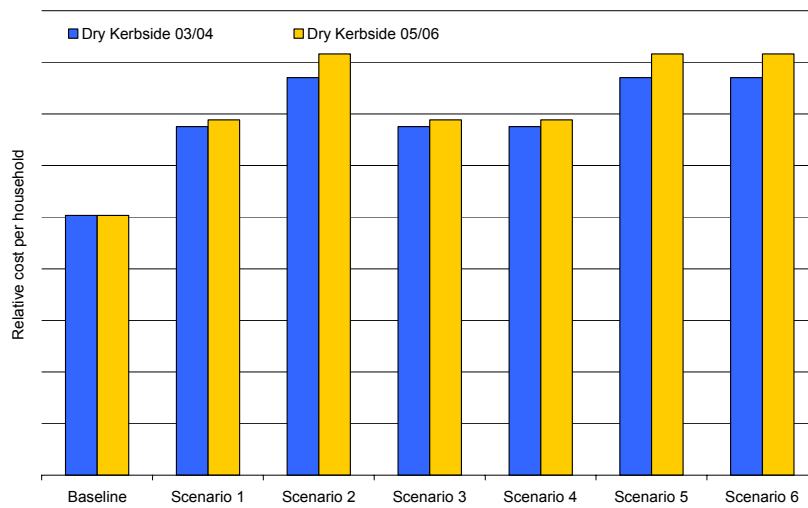
Comparison of total relative annual collection costs



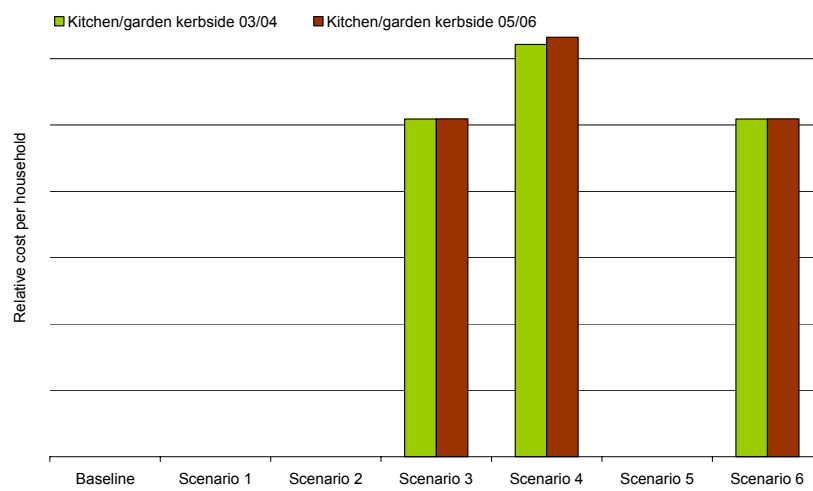
Relative annual collection costs per household for refuse collections



Relative annual collection costs per household for bring collections



Relative annual collection costs per household for dry recyclable collections



Relative annual collection costs per household for kitchen and garden waste collections

7.5 Summary and Conclusions

By using locally based data on waste arisings and composition of the whole household waste stream, together with local data on 'best practice' for capture rates that can be achieved, it was possible to construct a number of scenarios to explore the consequences in terms of recycling rates achieved of a number of policy options for improving recycling services. This type of analysis can be used in conjunction with evaluations of other aspects of the effects of these waste management choices, to provide a basis for judgements about the most desirable option.

These scenarios show what might be done not necessarily how it should be done. Local authorities using scenarios in this way to assess the potential recycling performance of different waste management options available to them – based on local circumstances and local data – need to decide how and whether the required capture rates can be met. Again judgement should be based on local experience. Material capture rate is a function of a number of factors including the level of service provision, public participation, materials targeted and the proportion of the target material captured by the scheme from participating households. Detailed on-going data collection of all these aspects and carried out in an integrated programme, and analysis of current performance, will be needed to identify where improvements can be made to achieve these high capture rates.

In building and exploring scenarios, comparative information produced by the cost modelling approach could be used by local authorities, alongside other measures of performance, to improve decision making for waste strategy planning. For instance the comparative total costs predicted for the case study authority for the six scenarios could be cross-referenced with the predictions of the recycling rates that would be achieved using the same scenarios for that authority, and as described earlier. Scenarios 4, 5 and 6 would all achieve the authorities BVPI target for 2003/4, but that only 5 and 6 would achieve the 2005/6 target. The cost analysis shows scenario 5 to cost less than either 4 or 6, and information of this type could influence or inform choices in the short or longer term development of strategy.

The costs presented in this Report are merely illustrative and are over simplified. More accurate modelling can be achieved with more accurate, local data. The analysis though has demonstrated that standard costs both enable the comparison of the costs of kerbside collections that are currently operating and allow comparative costs to be projected for alternative collection systems.

Cost is a vitally important factor for local authorities in assessing waste management options, and for this reason needs much more detailed exploration than has been feasible in this study. Except in this limited discussion of a standardised cost approach, this Report does not attempt to address economic issues in any detail, but simply acknowledges their significance. Despite much attention given to cost issues, it remains an area in great need for further investigation and analysis.

Hummel (2002) concludes that 'experience suggests that most collections are currently not operating in the most cost effective way, often a high participation is considered to be more important than a high capture'. A collection that experiences a high participation but a low capture will have a much higher cost than a collection with a low participation but a high capture. Therefore, costs extrapolated from even standardised data on current recycling collections will not provide reliable estimates of future kerbside collection costs, but will need to reflect changing assumptions about potential participation and capture rates, and other influencing factors. These issues are developed in a guide for local authorities to meeting statutory recycling targets through cost effective kerbside expansion (Hummel, 2003).

Chapter 8 - Source segregation and collection of municipal compostable waste: generating and using locally derived data

8.1 Introduction

Bring and kerbside collection schemes are the two main collection methods for source segregated dry recyclables and compostables. While bring schemes continue to play an important role in collecting specific materials for recycling, kerbside collection is now rapidly becoming established. This is especially true for dry recyclables, where DEFRA statistics show that the proportion collected from CA sites has decreased from 84% in 1995/96 to 64% in 2000/01, with kerbside collection increasing from 16% to 34% (DEFRA, 2002; NAW, 2003). With compostable waste the situation is not so clear and 89% of organic household waste composted was collected from CA sites, with only 11% being derived from the kerbside in 2000/01. However, while this proportion has remained relatively constant over the last few years it is inevitable that with increasing emphasis on meeting recycling and composting targets, methods other than bring site collection of compostable waste will be investigated and employed. This Chapter of the Report addresses decision making in relation to the introduction of appropriate collection systems for compostable waste. In particular, it considers how locally derived data relating to source segregation and collection systems might be helpful to decision makers, especially in terms of developing effective integrated waste management strategies.

Chapter 3 reviewed the many factors that determine the effectiveness of source segregation and collection schemes. Not all existing source segregation and collection operations appear to meet expectations. For example, it is notoriously difficult to design cost-effective kerbside schemes for compostable waste, which do not conflict with existing waste management activities and which deliver the appropriate volumes and the high quality of material required. In terms of developing effective integrated waste management strategies, every effort should be made to introduce source segregation systems, and in particular kerbside collection schemes, in ways that integrate with local conditions and established waste management facilities. However, doing this requires generating and applying much accurate local data and in practice this is often difficult to achieve.

In an attempt to minimise the high risk involved and to introduce kerbside schemes which are tailored to local needs, many local authorities first trial different approaches, equipment and facilities in selected geographical areas. There are many examples of comprehensive and complex kerbside trials being set up where the main aim is to optimise the performance of subsequent full-scale kerbside operations. In such cases, a feature often lacking is the absence of consideration given to alternative or complementary approaches. Very often, the effects of introducing kerbside collection on bring site arisings and home composting activities are not rigorously investigated and the relationship between collection options and recycling rates is also unclear. With kerbside collections of garden waste being cited as an important reason for year-on-year increases in waste arisings (Parfitt, 2002), it is vitally important that source segregation systems are introduced within clear integrated waste management frameworks.

This Chapter aims to explore some of these key issues. It focuses on the generation and use of locally derived data relating to waste collection rates for two different but potentially complementary approaches to implementing source segregation and collection schemes. In particular, the Chapter addresses the subsequent use of this data to predict recycling rates for different options and the effects of these on residual waste. Firstly, it explores key issues and data relating to current source segregation practises for compostable household waste. Case study material from Hampshire on the use of kerbside collection trials and on the evaluation

of HWRC performance is used to illustrate how locally based data may be derived. Finally, data from the Hampshire case study trials is used to illustrate how collection rate data may feed into predictive recycling rate scenarios and be used to estimate the effect on residual waste arisings and composition. Overall, the Chapter aims to illustrate how the collection and use of data in this way can aid decision making in terms of selecting best value, locally based integrated waste management options.

8.2 Source Segregation and Collection of Compostable Household Waste

Segregation at source is vitally important as it offers the opportunity of a high-quality feedstock and the prospect of an uncontaminated-composted product. Furthermore, the method of collection of municipal waste for composting is thought to be the single most important factor determining the physical state and type of feedstock (Evans, 2002). Hence, source segregation is considered to be a requisite for quality composting, and in addition, increased kerbside collection has been identified as a “necessity” if the recycling and composting targets are to be met (House of Commons ETRA, 2001, p16). This section investigates key aspects of source segregation and collection as practised in the UK. Current practises are first outlined and the composition of MSW is investigated as a means of estimating the amounts of compostable waste available for collection. Actual amounts of source segregated waste collected from typical trials, pilot schemes and full-scale operations are highlighted and the effect on the composition of residual waste as a result of collecting source segregated compostable waste is then addressed.

8.2.1 *Current issues and practice in source segregation*

Using DEFRA (and previous DETR) data, Table 8.1 shows how the quantity of waste collected for composting has grown since 1995, and illustrates the collection source and the proportion of overall recycling and composting derived from composting. This shows a considerable growth in kitchen and garden waste collected for composting. Although garden waste from bring sites and kerbside have increased, the proportion from each has remained relatively constant, fluctuating around 89-93% from civic amenity sites, and 7-11% from the kerbside, highlighting the very strong reliance on bring sites for garden waste collection. Bulson and Purbrick (2000) reported that the amounts of compostable household waste being collected by kerbside schemes in other European countries were much higher than in the UK: Netherlands (92%), Austria (80%) and Germany (45%). They also identified a number of local and national barriers precluding wider adoption of kerbside collection in the UK.

However, local authority emphasis on providing facilities for the collection of garden waste has been linked to year-on-year increases in the total amount of waste collected. For example, Parfitt (2002) showed that of the 30 authorities recording the highest total waste arisings only one had not targeted green waste for composting. This suggests that deliberate targeting of green waste, through HWRC and kerbside collection, may be diverting material from home composting or encouraging new garden material to be put into the waste stream which previously would have been left in-situ. In particular, increased kerbside collection of garden waste, while boosting WCA recycling rates, is likely to have the potential to create increasing amounts of new waste. Ensuring that sufficient recycling facilities are available to collect and compost all green waste currently disposed of in general waste would seem to be a priority. A level of recycling resources needs to be achieved that diverts current levels of green waste from landfill while not encouraging large amounts of new waste to be created. However, to date there has been insufficient experience recorded that identifies which approaches to green waste collection would achieve this. This Chapter draws on case-study experience to show how locally derived data can be used to investigate these issues and explore the effects of different collection options.

Virtually all household waste centrally composted in the UK at present is green waste. Since the focus of this Chapter is to illustrate how local data may be derived and used, much of the

emphasis will be placed on source segregation and collection of green waste only. Whilst composting of kitchen waste would contribute to the recycling and composting targets, its practice is currently limited, which may be partly due to difficulties in the collection and composting of kitchen waste compared to green waste. The highly putrescible nature of kitchen waste precludes the use of bring sites, and raises issues with kerbside collections including public health concerns related to problems such as odour and flies. In some areas of Europe with dedicated kitchen waste collections, such as Northern Italy and Spain, these problems have been alleviated with frequent collections. Following the introduction of the Animal By-Products (Amendment) (England) Order 2001 and the EU Animal By-Products Regulation (EC 1774/2003), the processes for composting waste that includes kitchen waste are subject to much tighter controls than the composting of green waste. Thus, although the targeting of kitchen waste would contribute to the recycling and composting targets, there are more difficulties to overcome compared with green waste, and it is unclear whether or how the collection and composting of kitchen waste will develop.

Despite the issue of increased waste arisings as a consequence of targeting green waste, there is some evidence that kerbside collections for green waste are gaining in popularity. A number of local authorities have recently invested in trial or small-scale pilot schemes in addition to several well-established operations. For example, Slater and Frederickson (2001) reported that the 1999 Composting Association survey confirmed increasing interest in kerbside collection of compostable waste as shown by the 73 local authorities either planning or introducing schemes. This was in contrast to the 42 kerbside collection schemes that operated at that time. Very little peer-reviewed and detailed information is available on the number, status and characteristics of kerbside schemes currently operating in the UK. A report undertaken by Avon Friends of the Earth (Mansell, 2001) studied 25 schemes in detail, many of which were trial status, and this highlighted the high diversity of the approaches to kerbside collection being adopted. Aspects of this diversity included waste type (kitchen and/or green waste), container size and type, frequency and manner of collection, participation (opt-in or opt-out) as well as cost (free or charged).

Table 8.1 Household kitchen and garden waste collected for composting

Year	Quantity collected for composting ('000 tonnes)	Quantity from bring sites ('000 tonnes)	Quantity from kerbside ('000 tonnes)	Percentage from bring sites	Percentage from kerbside	Proportion (of overall recycling and composting) from composting
1995/96	131	117	10	89	8	10
1996/97	282	261	21	93	7	16
1997/98	389	354	35	91	9	20
1998/99	462	428	34	93	7	21
1999/00	670	612	57	91	9	25
2000/01	816	731	85	89	11	28

Source: DETR (1997); DETR (2000b); DEFRA (2001); DEFRA (2002); NAW (2003)

8.2.2 Amounts of compostable waste available

Previous Government estimates of the proportions of biodegradable waste (53%) and putrescible waste, comprising kitchen and garden waste, (21%) normally found in municipal waste are now very dated and widely disputed and these low estimates were reflected in the England & Wales Waste Strategy (DETR, 2000a). In particular they appear to greatly underestimate the large amount of garden waste produced in the UK and it is likely that the amounts of biodegradable waste as well as organic waste in MSW are currently much greater than these dated estimates suggest. National and local estimates of the proportion of

compostable waste in MSW, clearly has an impact on the amount of compostable waste that is available for separate collection and composting.

Existing published figures for the average biodegradable fraction of the MSW stream range from 53 to 68% (e.g. Nesaratnam *et al.*, 1997; Parfitt, 2002). One study in the West Midlands of England found the biodegradable fraction to be 61% of MSW while the organic fraction was around 32% (MEL Research, 1994). This report also estimated that garden waste in refuse amounted to around 7.2% of the total with as much again being deposited directly to CA sites. Hence, in practice it is likely that the overall proportions of biodegradable waste and organic waste in MSW in the UK could be in the region of 60% and 30%, respectively. Garden waste could account for around 20% of MSW and these estimates are similar to other European countries (de Bertoldi, 1999). These higher estimates were confirmed by a recent Strategy Unit report (Parfitt, 2002) which found that the biodegradable fraction of household waste was 68% while the proportions of kitchen and garden waste in household waste were reported to be 17% and 20% respectively.

8.2.3 Amounts of compostable waste collected

This section investigates the typical amounts of organic material collected by source segregation and collection schemes. Bring systems (at CA/HWRC sites) and kerbside collection methods will be considered.

DEFRA statistics suggest that the both the number of CA sites, and the average quantity collected per site, has increased in recent years. However, in 1999/2000 the estimated quantity of garden-type waste collected per household per year halved to around 41kg per household, from an 80kg estimated in 1997/98. It appears that this was due to changes in reporting procedures; households served by CA sites had been extended to cover the majority of households. This significant revision underlines the importance of reporting collection rates on a well defined and consistent basis. The majority of sites that accepted green waste collected household green waste only, although a small proportion also collected local authority parks and gardens material and commercial green waste, all of which is usually recorded as household waste. DEFRA (2001) figures estimate that there was one CA site for around 24,500 households in 1999/00. On average, most local authorities currently operate 4 CA sites. In 1999/00 approximately 41kg per household was collected from CA sites (DEFRA, 2001), which fell to approximately 39kg per household in 2001/02 (DEFRA, 2003).

Experience from established schemes in Europe suggest that CA sites collect around 30-70kg per person served per year (Favoino *et al.*, 2002). Assuming approximately 2.5 persons per household in England, this suggests that CA sites in the UK could collect around 67-175kg per household served.

Slater (2003) surveyed all WDAs and WCAs in 2000 and reported 45 organic kerbside collection schemes in the UK, the vast majority (41) in England. Of the 45 operational schemes, 35 reported collecting 47,500 tonnes from the kerbside. Around 80% of schemes collected either garden waste only, or a combination of garden and kitchen (no cooked food) waste. Results showed an average of 218kg was collected from the kerbside per participating household per year, and around 86kg per household covered (around double that estimated by DEFRA). It has been suggested that the quantities collected per household potentially served, as estimated by DEFRA (43kg), could be misleading if interpreted without distinguishing between number of households in a LA area, number of households covered by a scheme, and number of households participating. Slater also found that opt-out kerbside schemes collected an average of 276kg per participating household per year. In terms of kerbside collection schemes, opt-out (mandatory) style participation would appear to achieve higher levels of participation and material recovery than opt-in (voluntary) schemes, and mandatory participation has been cited as the most significant scheme parameter (Everett and Pierce, 1993, p59).

Although there is little published information on organic kerbside collections, there is some data available from established schemes. Both St. Edmundsbury Council (1999) and Daventry District Council (2000) have established schemes and reported collecting over 300kg of garden and kitchen waste per household per year, and both schemes are based on opt-out participation. In a comprehensive study undertaken by Avon Friends of the Earth (Mansell, 2001), the wide variation in waste collection rates in the UK was highlighted. Out of 23 schemes contacted, the four top performing councils claimed to be collecting at least 300 kg per household in 2000/01 while the next eight collected between 190 - 270 kg per household. In particular, the Report showed the effect of charging for kerbside collection on collection rates. Charged schemes were reported to be collecting 20 to 140 kg/hh/yr compared with free schemes, which typically collected up to 300 kg/hh/yr. Also highlighted were the possible effects of bin size and weekly versus fortnightly collection on collection rates. Seasonal variation in the amount of waste collected at the kerbside and at CA sites was reported in the study, with the peak months (May - June) collecting around twice the annual monthly average and more than five times that of the low months (December - March).

These quantities are approaching some of the high collection rates observed for established schemes in Europe that combine garden and kitchen waste kerbside collections, which are typically in the region of 375-450kg per household per annum (Favoino *et al*, 2002). In regions of Italy, where intensive kerbside collection of kitchen waste is carried out in conjunction with high density bring schemes for garden waste, quantities range from the equivalent of around 225-500kg per household per annum. This range being influenced by the degree of urbanisation and the use of home composting, which is encouraged for garden waste (Favoino, 2000). In Australia, trials conducted into the kerbside collection of kitchen waste collected the equivalent of over 220kg per household per annum (ACT, 2002).

In general, data reported to date suggests that kerbside collections have the potential to collect greater quantities of compostable waste per household served compared with bring sites. However, it should be noted that compostable waste comprises garden waste and kitchen waste and at present only the garden waste fraction of household waste is collected through bring sites. It would be expected, therefore, that kerbside schemes that collect both garden and kitchen waste (possibly including cardboard) may collect greater quantities of material per household than bring sites. Although not widespread, some kerbside collection schemes in the UK targeting compostable household waste would appear to be reporting similar collection results to established European schemes.

8.2.4 Effect on residual waste

The effectiveness of source segregation and collection schemes will clearly affect the amount and the composition of residual waste produced by householders. The amount and the composition of residual waste will in turn contribute to decision making relating to processing and disposal options for residual waste. Maximising the amount of organic or biodegradable material removed from the household waste stream may alter significantly the characteristics of residual waste, making it more or less appropriate for recovery options such as energy from waste (EfW) or mechanical and biological treatment (MBT). However, despite the importance of predicting the effect of source segregation on residual waste, little published information on this subject is available.

Source segregation and collection schemes that target compostable waste have a particular need to understand the effects of these systems on residual waste. Research in the Netherlands and Germany has shown that even when effective source segregation of kitchen waste is practised, residual waste can still contain 40-50% food-type waste. One reason for this is that source segregation and collection of dry recyclables can be more effective than for putrescible material, thereby concentrating remaining kitchen waste in the residual waste. In Italy, even when source segregation of food waste was optimised, residual waste was found to contain 10-20% putrescible waste (Favoino *et al*, 1999). The Strategy Unit (2002) estimates

that the biodegradable content of residual waste is 65% compared with all household waste (68%). They also estimate that by 2020, the biodegradable content of residual waste will fall to 54% due to increased source segregation and collection as well as increases in levels of home composting.

Clearly, understanding the effect of different source segregation and collection systems on the amount and the composition of residual waste is fundamental to devising effective integrated waste management strategies that aim to manage the total household waste stream. Chapter 9 of this Report further develops this theme and section 8.4 of this Chapter investigates the use of data from source segregation and collection trials to estimate effects on residual waste characteristics.

8.3 Generating and Using Source Segregation Data: Hampshire Case Study

The main aim of this section is to use case study material to explore some key issues related to generating locally-derived information, in particular from kerbside collection trials and from HWRC use. The case study will focus mainly on waste collection rates and these will be used in section 8.4 to illustrate how local data may be used to calculate recycling rates for specific schemes, enabling valid comparisons of different schemes to be made. It will also illustrate how the performance of source segregation and collection operations can affect the amount, composition and characteristics of residual waste, thereby supporting more effective decision-making about residual waste options. In doing this, it is acknowledged that any BPEO analysis would need to consider a wider range of criteria in addition to collection rates, such as economic and environmental impacts as highlighted in Chapter 1 of this Report. However, detailed consideration of these criteria is beyond the scope here.

The first part of this study will briefly describe individual kerbside trials in each of two selected trial areas before analysing the performance of these in terms of collecting green waste. The second part will explore selected aspects of HWRC use. The performance of HWRCs in terms of green waste collection will be considered and in particular, this will be related to individual WCAs green waste policies. The case study material is drawn from within the areas served by Project Integra, in Hampshire.

As previously reported, around 90% of organic material collected for composting in the UK comes from CA or HWRC sites. Prior to undertaking this case study, all waste material collected by Project Integra for composting at centralised sites had been green waste, sourced from HWRCs. However, other waste types and collection methods were also investigated and these included pilot and other schemes exploring the merits of green waste collection using kerbside methods. As part of these continuing investigations, in spring 2001 a wide ranging programme of kerbside collection trials was initiated in Southampton City Council, East Hampshire District Council, Gosport Borough Council and the New Forest District Council. The Open University project team undertook a two-stage evaluation of these trials and expanded operations in autumn 2001 and summer 2003. The case study material used in this Report was derived from this programme of kerbside green waste collection trials, coupled with an analysis of performance data for HWRCs. Selected findings, mainly related to waste collection rates, from the Southampton City Council and the East Hampshire District Council kerbside collections are presented here. In addition, HWRC arisings and waste composition for the whole of Hampshire and historical data on these parameters will also be drawn on during the analyses in this section. Much of the original data used in this section was collected specifically for this Report during the first evaluation stage, and has been consolidated with findings from the second evaluation stage undertaken for Hampshire County Council. To maintain consistency throughout the Report, all findings and discussion items will be focused on the whole of Project Integra, rather than on individual WCAs.

8.3.1 *Selected kerbside collection trials*

Characteristics of the two selected trials, Southampton City Council and East Hampshire District Council, are presented in Insert 8.1 and Insert 8.2. The trials suggest that a wide variety of methods can be used to collect green waste from the kerbside and with the exception of one particular trial, householders appeared to participate enthusiastically in the trials. In general, the amounts collected are broadly in line with kerbside collection rates reported elsewhere. In the trials presented here, the green waste collected at the kerbside was inspected by collection crews and physical contaminants removed, before delivery to composting sites. The quality of the collected material when received for composting was very high and was suitable for composting.

Insert 8.1: Hampshire case study – Southampton City Council collection trials

On commencement of the green waste collection trials in June 2001, Southampton City Council targeted the three separate areas of Holly Hill, Bassett and Woolston/Weston.

Woolston and Weston - the total number of households covered by the trial in Woolston and Weston was 324. Participation was opt-in, and householders were originally supplied with an 80 litre capacity dustbin, collected fortnightly (monthly in Jan/Feb 2002). In March 2002 householders that had opted into the scheme were supplied with a re-usable polypropylene bag, and collection frequency was increased to weekly (monthly in Jan/Feb 2003). If they wished, householders could continue to use the 80 litre dustbin.

Holly Hill - the total number of households covered by the trial in Holly Hill was 391. Participation was opt-in. Originally householders were asked to supply their own bag/container, but in March 2002 householders that had opted into the scheme were supplied with a re-usable polypropylene bag. Collection was weekly throughout the trial (monthly in Jan/Feb).

Bassett - the total number of households covered by the trial in Bassett was 358. Participation was opt-in, and householders were supplied with re-usable bags (similar in style to the ones introduced mid-trial in Holly Hill and Woolston/Weston). Collection was weekly throughout the trial (monthly in Jan/Feb).

Although different containment methods and collection frequencies were used in different areas when the trials commenced, since March 2002 they were more consistent between areas – all had re-usable bags and weekly collections. Collections were free of charge and the green waste was collected using a caged vehicle with bag-splitter. Householders in Southampton (and trial areas) were allowed to dispose of green waste in the normal refuse wheeled bin. The effect of kerbside collections on HWRC arisings or the amount home composted was not determined. Technical problems prevented weighing of residual waste so it was not possible to determine the effect of green waste collection trials on residual waste.

Questionnaires were sent out to households during the trials (response rate 45%). Participants in the trials confirmed that before the trials started, they disposed of green waste in three main ways: 43% said that they used the wheeled refuse bin; 33% said they home composted; and 40% said they used a HWRC or a combination of these. Responses indicated that 33% of trial participants continued to use their home composting unit.

Insert 8.2: Hampshire case study – East Hants District Council collection trials

On commencement of the green waste collection trials in May 2001, East Hants District Council targeted two separate areas.

Northern area (rural villages including Beech) – the total number of households covered by the trial in the Northern area was 722 properties.

Southern area (Horndean) – the total number of households covered by the trial in the Southern Horndean area was 930.

Both green waste collection schemes were part of a larger alternate weekly collection trial (dry recyclables alternating with residual waste, additional collection for green waste). On commencement of the trials, green waste was banned from residual waste collections in the trial areas. All householders in the trial areas were supplied with a reusable polypropylene bag for their green waste, with a maximum capacity of 25kg. There was no direct charge to householders for the collections, which were on a fortnightly basis on the same day as the recyclable collections. Green waste set out in the trial areas was collected in a converted freighter, which allows mechanical loading of waste. The green waste was first inspected by the crew and any contaminants present could be removed during two stages of loading into the vehicle. Waste compositional analysis was undertaken before and during the trial. The effect of kerbside collections on HWRC arisings or the amount home composted was not determined.

Questionnaires were sent out to householders prior to the trial and again in July 2001. The questionnaires focused mainly on the effects and acceptability of alternate weekly collections. In particular it was found that home composting was much more commonly practised in the northern trial area (65% of respondents) compared with the southern area (33% of respondents).

After the one-year trial, East Hants introduced a borough wide kerbside collection scheme for green waste. The scheme was rolled out in 2 phases, Phase 1 was introduced in May 2002, and Phase 2 commenced at the end of October 2002. Participation in the scheme was on an opt-in basis, and an annual charge of £12 per re-usable sack was introduced, which extended to the trial area which had not previously been charged for the fortnightly service. Introduction of the scheme followed a ban on accepting green waste in general waste collections.

8.3.1.a Participation and collection rates

The initial trials in Southampton covered a two year period, throughout which Southampton City Council maintained detailed collection records on the number of bags collected for each household participating in the trial. Careful monitoring of collections allowed monthly collection tonnages to be calculated as well as monthly participation rates for each of the trial areas, which are illustrated in Insert 8.3, and Insert 8.4. As well as illustrating seasonal variations, this performance data showed a 'settling in' effect, with increased participation and amounts collected per household in the second year of the trial.

Insert 8.3 Hampshire case study – Southampton participation and collection rates

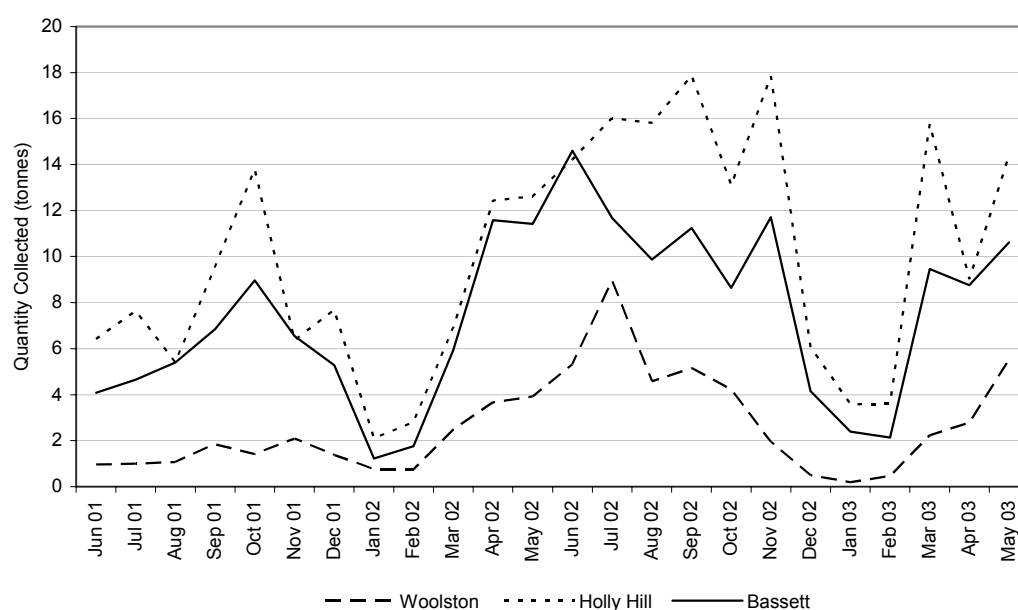


Figure 8.1 – Quantity of green waste collected each month in the Southampton trial areas

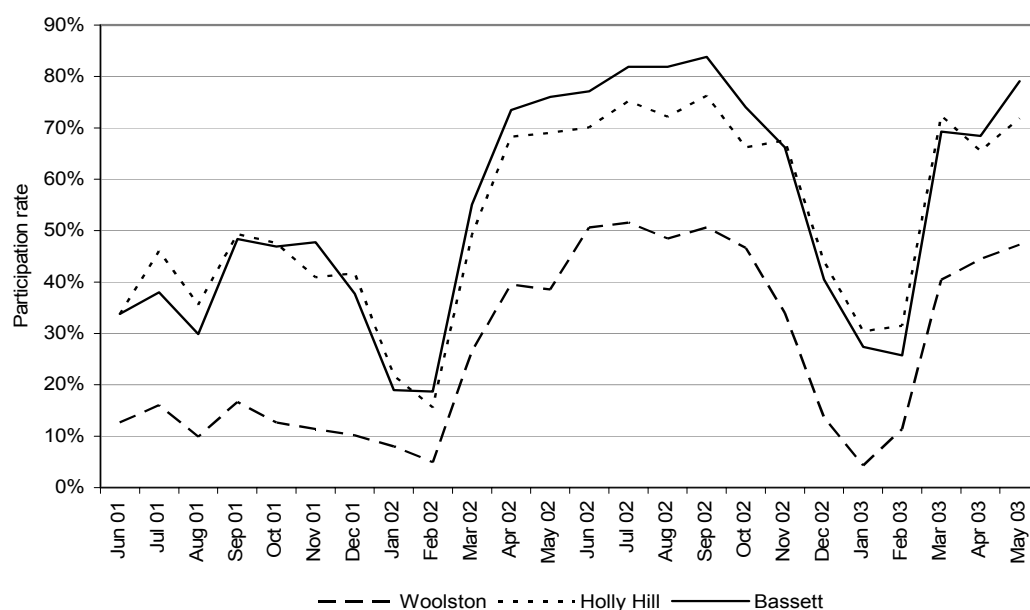


Figure 8.2 – Monthly participation rates in the Southampton trial areas

Comparing Figure 8.1 and Figure 8.2 shows a seasonal pattern for tonnages collected and participation rates, as would be expected. However, it is interesting to note that although Bassett had a higher participation rate than Holly Hill during summer 2002, more green waste was collected in Holly Hill than Bassett, which is also reflected in greater quantities collected per household in Holly Hill (see Table 8.2). As the participation rate for Bassett peaks at over 80% during July and August 2002, it would be expected that the overall quantities collected increased accordingly, but Figure 8.1 shows that this starts to fall during the same period, suggesting that less was being collected per participating household relative to other spring and summer months.

Insert 8.3 cont

Participation rates illustrated in Figure 8.2 were calculated as households that set-out green waste at least once every four weeks. In the first few months of the trial participation rates for Holly Hill and Bassett were very similar, ranging between 34% and 49%, whilst participation in the more built up areas of Woolston/Weston was much lower, ranging between 10%-17%. From March 2002, a significant increase in participation was observed in all trial areas, peaking in the summer months at around 84% for Bassett, 76% for Holly Hill, and 52% for Woolston/Weston. This increase coincided with a change to collection and containment variables. Collection frequency in Woolston/Weston was increased from fortnightly to weekly, and participating households in Woolston/Weston and Holly Hill were issued with re-usable bags. However, if the change over to re-usable bags was an important factor for increasing participation, one would not expect to observe an increase in participation in Bassett (as households in Bassett continued to use their existing re-usable bags). As a similar increase in participation was observed in Bassett, it suggests that re-usable bags were not an important contributing factor. Some of the increase observed during the second year may be due to more householders becoming aware of the trials as communication messages filter through and the trial 'beds-in'. The increase in quantities collected during the second year of the Southampton trials follows a similar pattern to green waste collection trials conducted elsewhere over the same time period (Bexley Council, 2003).

The variation in quantities collected and participation rates shown in Figure 8.1 and Figure 8.2 shows the importance of continuous monitoring. As well as variations between seasons, this monitoring highlights variation within seasons, and the relationship between participation levels and quantities collected. Automated and semi-automated systems, such as barcodes and smart-chips, are becoming increasingly available and facilitate continuous monitoring. The disadvantage of infrequent monitoring that just provides a snapshot is that the true pattern of tonnages collected and participation may not be revealed and peak and trough months may be missed (e.g. quantities collected peaked in Bassett in June 02, compared to Sept and Nov in Holly Hill, and July in Woolston/Weston). Not identifying such peaks may result in a mismatch between resources and demand. The level of detail provided by continuous monitoring or frequent sampling also reveals changes in the quantities collected compared with participation. For example, the similar pattern of participation in each of the trial areas illustrated in Figure 8.2 is not reflected in the pattern of tonnages collected. This suggests that there are differences in participants' behaviour (e.g. there may be different set-out rates or differences in quantities per set-out) worthy of further investigation.

Participation in the East Hants trials was frequently checked by council officers and it was found that 90% of households regularly set-out green waste for collection. However, continuous monitoring of participation was not undertaken in the trials in East Hants, and hence it is not possible to compare performance data and participation rates at the level of detail of the Southampton trials. However, it is possible to compare quantities collected per household covered in the trials in the two districts, and this is illustrated in Insert 8.4 and Table 8.2.

Insert 8.4 Hampshire case study – Southampton and East Hants participation and collection rates

The East Hants trials were undertaken for one year, and 2.8 kg/hh/week per household covered by the scheme was collected in the northern area and 3.1 kg/hh/week for the southern area. The lower amounts collected at the kerbside in the northern area may be due to much higher levels of home composting reported in this area.

Table 8.2 – Average quantity collected per household covered

District	Trial area	Number of households in trial area	Average quantity collected per household per week for households covered (kg/hh/week)	
			Year 1 (2001/02)	Year 2 (2002/03)
Southampton	Woolston / Weston	324	1.3	2.5
	Holly Hill	391	4.6	7.2
	Bassett	358	4.0	5.7
East Hants	Northern area	722	2.8	n/a
	Southern area	930	3.1	n/a

Note: n/a is not applicable, as the trials in East Hants were undertaken for one year

Both the northern and the southern trial areas in East Hants yielded greater quantities per household covered compared with the Woolston/Weston trial in Southampton, but less than Holly Hill and Bassett. Without more detailed information about individual trial characteristics such as detailed participation rates and garden size, it is difficult to comment on the degree of variation in the rates observed. Nonetheless, it is interesting to note that trials that collected green waste on a fortnightly basis (Woolston/Weston, and the northern and southern areas in East Hants) yielded less quantities per household covered compared with the weekly collections (Holly Hill and Bassett).

Table 8.2 also shows the effect of the trial settling in as mentioned above, with increased quantities collected per household covered in the second year compared to the first year for all the trial areas in Southampton.

Estimating an average quantity collected per household per week obviously masks seasonal variations. On average, at least twice as much was collected per household covered in summer months. For example Woolston, Holly Hill and Bassett collected 3.3kg, 8.8kg and 7.2kg per household per week respectively during the summer months compared with 0.6kg, 4.4kg and 2.9kg per household per week respectively during the winter months.

When evaluated for this Report, it can be seen that the two higher yielding weekly kerbside collection trials in Southampton and the alternate weekly collection trials in East Hants were collecting around 3 to 5 kg/hh/week from households covered by the trials in their first year of implementation, rising to between around 5 to 7 kg/hh/week in the second year for the two higher yielding trials in Southampton.

Detailed comparisons of the data from these specific Hampshire trials with household organic collection schemes in the UK or elsewhere is outside of the scope of this Report. However some comparison may be useful. Collection rates for Italy, where kerbside collection of green waste is beginning to develop, are comparable to the Hampshire trials. Published Italian studies suggest that around 3-4 kg/hh/week can be achieved for kerbside collection of garden waste. In the UK, the two top performing councils employing kerbside

collection for garden waste only, achieved around 4-5 kg/hh/week (Mansell, 2001). Extensive trials undertaken over a 2 year period in Bexley recorded an average of between 4-5 kg/hh/week, and within this average the most successful trials recorded around 6 kg/hh/week (Bexley, 2003).

The findings from various trials presented in this Report relating to the amounts of green waste collected at the kerbside do not take into consideration the amounts of green waste possibly diverted into kerbside collection from HWRCs and from home composting. Obtaining quantitative information on the numbers of home composters and amounts composted in each trial area prior to the commencement of the trials was not a feature of the programme of trials featured here. However, surveys in some trial areas sought to identify general trends in terms of the effect on home composting activities. Equally, apart from the East Hants trial areas, it was not possible to determine the effect of the kerbside collection of green waste on the amount and composition of residual waste. None of the trials attempted to evaluate how kerbside collection affected HWRC arisings or sought to determine if the kerbside collections encouraged additional waste to be created in the system. However, since the post-trial introduction of a borough wide green waste kerbside scheme in East Hants, there is preliminary collection data on kerbside and HWRC use which is discussed below.

It would be recommended that future kerbside trials should determine the effect that kerbside collections have on waste generation, HWRC use and on home composting activities. Mapping kerbside collections and HWRC arisings using GIS-based systems and determining the environmental impact of collection policies using WISARD or similar tool would be useful (see Chapter 1 and Chapter 4). Future trials should also ensure that collection data are reported on a consistent basis such as kg/hh/wk for households served and participation rates are also recorded on a consistent basis.

8.3.1.b The effect of charging for green waste kerbside collections in East Hants

The trials in Southampton and East Hants had no direct charge to the householder. After their one-year trial, East Hants introduced a borough wide kerbside collection scheme. The scheme was rolled out in 2 phases, Phase 1 was introduced in May 2002, and Phase 2 commenced at the end of October 2002. Participation in the scheme was on an opt-in basis, and an annual charge of £12 per re-usable sack was introduced, which extended to the trial area which had not previously been charged for the fortnightly service. Introduction of the scheme followed a ban on accepting green waste in general waste collections. Prior to rolling out the scheme across the district, households in the trial area were asked whether they would be willing to pay the annual charge for green waste collections. Around 40% of respondents said they would be willing to pay, which was hoped would be reflected across the district. However, initial uptake was lower than anticipated. During Phase 1 around 15% of households covered opted-into the scheme and this increased to 18% during the early stages of Phase 2. Following a promotional campaign up-take has increased to around 25% across the borough. In light of the settling in effect experienced in the Southampton trials, and the increased participation rates in year two, East Hants may expect to see a steady increase in uptake as the scheme becomes established.

As the charged kerbside collection scheme had not been in operation borough wide for a one year period at the time of writing this Report, it was not possible to compare annual averages quantities collected per household for the trials and the new scheme. However, for comparative purposes it has been possible to take a snapshot of one month, although it should be noted that this will mask peaks and troughs throughout the year as discussed above. A comparison of amounts collected for the month of June (as a month common to each phase of borough wide implementation and the trials), was selected to see the effects of participation.

Table 8.3 – Quantity collected per household covered for a one month period common to the trial area, Phase 1 and Phase 2

Area	Month / Year	Charge Basis	Average quantity collected per household covered (kg/hhold/week)
Trial areas	June 01	No charge	3.76
Phase 1	June 02	£12 per sack per year	0.71
Phase 2	June 03	£12 per sack per year	1.04

Table 8.3 shows a drop in quantity collected per household covered, which reflects a drop in participation, from the trials with free collection, to Phase 1 and 2 and the introduction of the charged scheme. However, there is an increase in quantities collected per household covered following the moves from Phase 1 to 2 and introduction of promotion initiatives.

The Strategy Unit has recommended the charging framework for household waste be restructured to allow Councils the option of introducing a direct charge for general waste collections. At present Councils are required to collect general waste at no direct charge to householders, although a direct charge can be made for the collection of certain household fractions, including garden waste. Introducing a charged kerbside collection for green waste may be attractive to Councils for a number of reasons. Importantly, a direct charge allows Councils to offset the costs of collection. In addition, there is evidence to show that charged schemes attract fewer participants than free schemes (Slater, 2003), which is supported by the experience in East Hants. The number of participants will obviously affect the quantities of green waste collected, and limiting participation will limit quantities collected. However, this may be an appropriate strategy if research carried out by Councils has shown that free kerbside collections have led to green waste being diverted from home composting and HWRC to kerbside collections.

8.3.1.c The effect of green waste kerbside collections on total waste arisings and green waste collected from HWRC in East Hants

As discussed above, the introduction of green waste kerbside collections is likely to divert some green waste previously taken to HWRC, and may lead to an increase in waste collected, e.g. from green waste previously home composted or left in situ.

When assessing the impact of green waste kerbside collections and whether new waste has been attracted into the collected waste stream, it is essential to consolidate quantities collected from the kerbside with HWRC data. However, the nature of trials means that although the trial area covered should be representative of the district, they usually cover only a small fraction of the districts' population. As HWRCs can be accessed by all residents within a district it is very difficult to quantify the impact on tonnages collected at HWRC as a result of trials, although HWRC use by the trial participants could be investigated through participant surveys. It is more appropriate to quantitatively assess the effect of green waste taken to HWRC sites as a result of green waste kerbside collection schemes when the schemes are implemented district wide.

In East Hants, the introduction of district wide green waste kerbside collections followed a ban on accepting green waste in general waste collections. The ban was introduced in 2001, more than 6 months before the first phase of the district wide scheme. Initial indications are that the effect of the district wide scheme and the ban does not appear to have attracted 'new' waste to kerbside collections. The amount of total household waste and recyclables collected per household (kerbside and HWRC) in East Hants remained relatively stable pre and post trial and district wide scheme (1184 kg/hhold in 1998/99 and 1189 kg/hhold in 2002/03), whereas the amount of waste and recyclables collected from HWRC per household almost

doubled, from 225 kg/hhold in 1998/99 to 413 kg/hhold in 2002/03. Some of this increase will be a result of the ban on accepting green waste in general waste collections.

As discussed above, charged collections are likely to attract fewer participants compared with free schemes, and are therefore likely to offer less potential for diverting green waste from HWRC and for attracting new waste for collections. In order to establish a more accurate picture of whether this is the case in East Hants it is recommended that further analyses should be conducted once the scheme has been in operation district wide for at least a 12 month period (i.e. 2003/04).

8.3.2 Green waste collection from HWRCs

Hampshire is well served by the network of HWRCs and a significant proportion of total annual MSW arisings (22%) were generated by HWRCs. The national average for the contribution of waste from HWRC sites to total MSW arisings at that time was 19%. It is normal for householders in each of the Project Integra districts and Unitary Authorities to have access to many HWRCs, located within and outside local authority boundaries.

Insert 8.5 Hampshire case study – green waste collection from HWRCs in Hampshire

In 2001, Hampshire County Council operated 26 household Waste Recycling Centres (HWRCs). Green Waste was collected from 25 of the HWRCs and taken to 3 composting sites operated by Hampshire Waste Services.

From data supplied by Hampshire County Council for 1998/9 the amounts of green waste collected at HWRCs per household served for each WCA, can be calculated as shown in Table 8.4.

Table 8.4 - HWRC green waste arisings in 1998/9

Area	HWRC green waste (kg/hh/wk)	HWRC green waste (kg/hh/yr)
Basingstoke	0.94	49
East-Hampshire	1.17	61
Eastleigh	2.33	121
Fareham	1.50	78
Gosport	1.75	91
Hart	0.78	41
Havant	1.99	103
New-Forest	2.67	139
Portsmouth	0.55	29
Rushmoor	1.99	104
Southampton	0.42	22
Test-Valley	1.00	52
Winchester	1.14	59
Mean for Hampshire	1.40	73

In 1998/99, HWRCs in Hampshire collected on average 73 kg/hh/year for the population served (Table 8.4 in Insert 8.5). This equates to approximately 1.4 kg/hh/week and this mean is consistent with national and European figures. The wide disparity in quantities collected per household between districts, illustrated in Table 8.4, will be due to a many factors, including distance to HWRCs, waste collection method or ease of access. One important factor related to green waste capture rates through HWRCs use by householders will be the extent to which green waste is allowed in residual waste collections, effectively providing a very convenient and free service for the householder, but limiting green waste for composting.

Table 8.5 illustrates a snapshot of green waste capture rate (predominantly through HWRC) for a selection of districts in Hampshire in 1998/99, and shows that districts that banned green waste from residual collections captured a much greater proportion of the green waste for composting through HWRC compared to districts that accepted green waste in residual collections. Taking the average across all the Hampshire districts for 1998/99 reveals a mean capture rate of approximately 60% by HWRC for districts that restrict green waste in residual waste, compared to a mean capture rate of 29% for districts that allow green waste to be deposited with residual waste.

Table 8.5 - Available and collected green waste in 1998/9

Area	Capture rate (%)	Is green waste collected in residual/general waste?
New-Forest	63	No
Havant	57	No
Gosport	54	No
Winchester	35	Yes
Basingstoke	31	Yes
Fareham	26	Yes

Hence, Table 8.4 and Table 8.5 suggest that there is potential for increasing significantly the amount of green waste collected for composting in the area served by Project Integra. This may be achieved by improving the performance of HWRC collection of green wastes in lower performing areas through imposing restrictions on green waste in residual waste containers.

It may be concluded from this section that there are many ways of making use of locally based data to increase waste collection rates of compostable household waste. In this study kerbside collection trials and enhanced collection through HWRCs were investigated. It is not always the case that maximising collection rates should be the preferred approach since diverting large amounts of green waste, using kerbside collection for example, may have the effect of decreasing HWRC arisings and home composting activities as well as creating new waste in the system. A charged kerbside collection scheme for green waste is likely to attract fewer participants than a free scheme, which will limit overall quantities collected and will be less likely to divert green from HWRC and home composting. These effects need to be investigated when kerbside collection trials are set up. Other approaches, such as enhancing existing CA site collection and promoting home composting, may deliver less compostable waste to be processed, and hence contribute less towards recycling and composting targets, but could be very cost-effective solutions in terms of the overall integrated waste management strategy.

However, fundamental to any decision relating to the adoption of collection schemes is the need to know the effects of particular schemes or management systems on overall recycling rates and on residual waste characteristics.

8.4 Modelling the Effect of Green Waste Collection Systems

This section will use the scenario and modelling techniques adopted throughout this Report and aims to illustrate how potential increases in compostable green waste collections (from kerbside introduction or enhanced HWRC operation) can be compared in relation to recycling rates and residual waste characteristics. HWRC performance and kerbside trials data from the case study section will be modelled using the scenario approach introduced in Chapter 7 and the relative effectiveness of the two systems to divert green waste into composting will be discussed. Further modelling of the data will be undertaken to determine the effect that each approach has on the amount, composition and characteristics of residual waste. These scenarios are based on assumptions made from the data collected during the trials. They are not meant to be prescriptive or absolute, but rather they are meant to illustrate and exemplify how data can be used in scenarios to help inform decision making.

While it would be possible to use very specific data to estimate recycling rates for individual districts, for the purpose of this Report it is intended to aggregate the data to the level of the area covered by Project Integra. To derive a collection estimate, quantities collected per household covered from the Southampton trial were averaged (as these covered a two year period), and aggregated for the whole of Hampshire. This assumes that an average of 4.2 kg/hh/week of green waste (per household covered) could be achieved with a free kerbside collection (similar to the results of the trials in Bexley and outlined earlier). Ideally, data from individual trials in each collection district should be aggregated.

The first scenario in Table 8.6, Baseline (1998/99) has been used throughout this Report and is included here for comparison purposes. The other three scenarios are based on the case study data outlined above. The first two, [Baseline + GW Kerbside Charged] and [Baseline + GW Kerbside (Trials data)], draw on experience and collection rate data from the charged scheme in East Hants and free kerbside collection trials in East Hants and Southampton. The final scenario, [Baseline + improved HWRC GW collection] is derived from improving HWRC performance by restricting GW in residual waste.

At this stage in the analysis it is probably sensible to review the nature of the existing scenario and to describe the new ones in more detail. Baseline (1998/99) assumes status quo with practises and policies relating to HWRC GW collection in 1998/99.

The scenario [Baseline + GW Kerbside Charged] draws on collection data from the charged scheme compared to collection data from the free kerbside trials in East Hants. From this data, it is assumed that fewer households participate in charged kerbside schemes compared to free ones, and that charged schemes may collect around one-quarter of that collected in free schemes (based on per household covered, see Table 8.3 above). Given an average of 4.2 kg/hh/week could be achieved with a free kerbside collection; this charged collection scenario assumes that 1.05 kg/hh/wk could be achieved. In addition, because no data is available, either nationally or from the trials, on the effect of kerbside collection on the possible diversion of waste from home composting or the HWRC network, additional assumptions have been applied to this and the following scenario. In this scenario it is assumed that the proportion of green waste for HWRC and home composting remains constant, and is not diverted into the charged kerbside collections. Although this reflects the post-trial experience in East Hants, these were preliminary findings from the first stages of district wide implementation. In reality it is likely that some waste will be diverted from HWRC as a result of charged schemes, but that this is likely to be less than with free schemes. To account for these factors effectively, more accurate estimates should be derived from more comprehensive trials.

The scenario [Baseline + GW Kerbside Free] assumes that 4.2 kg/hh/week could be achieved from free kerbside collections, as found during the Southampton trials. As with the previous scenario, because appropriate data is not available, additional assumptions have been applied concerning green waste diverted from HWRC and home composting. These assumptions are that there will be a 50% diversion of green waste from the HWRC network and that a further 50% "new waste" will be created as a result of reduced home composting and increased gardening activity. These are theoretical assumptions that should be tested and revised, and they highlight the need for data from trials and schemes that monitor the dynamics between kerbside collections, HWRC and home composting.

The scenario [Baseline + improved HWRC GW collection] is based on the case study findings in the previous section where it was found that HWRC collection rates may be doubled by restricting GW in residual waste. It is assumed here that the districts in Hampshire that did accept green waste in residual waste adopt this policy and double their HWRC arisings as a result, while no change in HWRC arisings was assumed for those WCAs which restricted GW in residual waste.

Table 8.6 Projected recycling rates

Scenario	Contribution to overall recycling rate from dry recyclables (%)	Contribution to overall recycling rate from green waste (%)	Overall recycling rate (%)
Baseline scenario (1998/99)	13	6	19
Baseline + GW Kerbside Charged	13	11	24
Baseline + GW Kerbside Free	12	20	32
Baseline + improved HWRC GW collection	13	11	24

8.4.1 Effect on recycling rate

Table 8.6 shows that the Baseline (1998/99) scenario results in a contribution to the overall recycling rate from dry recyclables of 13% and 6% from green waste, giving a total recycling rate of 19%. The 6% from green waste is derived from green waste at HWRC, and represents a capture rate of around 32% (of total green waste available). The remaining scenarios assume that no change is made to recycling activity for dry recyclables. Baseline + GW Charged shows that a charged scheme, with around one-quarter of householders choosing to take-up the scheme, would increase the recycling rate from green waste from the 6% baseline to 11%, which represents a green waste capture rate of around 53%.

It is estimated that an 11% contribution to overall recycling could be achieved without the need for introducing a kerbside scheme by increasing the quantities collected at HWRC. In the Baseline + improved HWRC GW Collection illustrated here, an increase from the 6% baseline to 11% was achieved as a result of restricting green waste in residual waste. This would be politically sensitive in some areas but adopting this approach would appear to be a particularly cost-effective option for increasing overall recycling rates with minimum financial implications and impact on existing services. This may be a very attractive approach if other elements in the integrated waste management strategy contribute to delivering the target recycling rate.

If output from an introduced kerbside collection scheme matched the estimated trial output (i.e. 4.2 kg/hh/week), then the overall recycling rate would increase to 32%, and the contribution from green waste would increase from the 6% baseline scenario to 20%. A very important observation from this analysis is that the 20% contribution to recycling from green waste would require a capture rate of around 100%, which is unlikely to be achieved in practice. This scenario assumed that 50% of garden waste previously taken to HWRC was diverted to the kerbside, and that there was a 50% increase in garden waste arising as a result of diversion from home composting and increased gardening activity. This would lead to an overall increase in total waste arisings of around 4%. This increase in overall waste arisings accounts for the fall in the contribution from dry recyclables from 13% to 12%. So as well as having an unrealistic capture rate, the increased recycling rate from green waste in this scenario needs to be offset against increased waste arisings.

It is far from clear that a free kerbside collection scheme would increase garden waste arisings by 50%. More comprehensive trials would be needed to clarify the assumptions used in these illustrative scenarios and the very important issues relating to possible waste creation caused by the introduction of extensive kerbside collection services. Nevertheless, it can be seen that focusing on the introduction of an extensive kerbside collection system for green waste, would contribute significantly to achieving the overall target recycling rate. In terms of meeting recycling targets this would clearly reduce the need to divert kitchen waste from residual waste but the collection of dry recyclables for recycling would need to conform to the overall integrated waste management strategy.

8.4.2 Effect on residual waste

This section aims to explore the effect that different methods of source segregation and collection of green waste may have on key residual waste parameters such as putrescible waste content, carbon content and calorific value. From Table 8.7 it can be seen that the introduction of a free kerbside collection system for green waste in the areas served by Project Integra would collect approximately 5,000 tonnes more than by introducing a charged kerbside scheme or by enhancing HWRC arisings in the manner suggested. Compared with the baseline scenario, both methods of collection would reduce the moisture content of residual waste and increase the calorific value by a significant degree. This would clearly enhance the fuel value of the residual waste, making further recovery using energy from waste facilities a more attractive option. An alternative approach to processing residual waste, using MBT systems for example, would not be appreciably affected by removing greater amounts of green waste, since the waste stream would still contain a high proportion of highly putrescible kitchen waste. The effect of different scenarios on the key residual waste parameters are developed more fully in the following Chapter.

Table 8.7 Residual waste characteristics

Residual waste parameters	Baseline Scenario	Baseline + GW Kerbside Charged	Baseline + GW Kerbside Free	Baseline + improved HWRC GW collection
Mass (t)	484,074	414,453	409,199	414,453
Moisture content (%)	35	31	31	31
Ash content (%)	20	22	22	22
Carbon content (%)	25	26	26	26
Calorific value (MJ kg ⁻¹)	10.32	10.96	11.14	10.96
Thermal content (GJ)	4,995,600	4,542,400	4,558,500	4,542,400

8.5 Conclusions

This Chapter focused on the generation of locally derived data and its use in decision making in terms of implementing source segregation and collection schemes for green waste. In particular, the Chapter illustrated how waste collection data for two different but potentially complementary approaches, could be used to predict recycling rates and the effects that each would have on residual waste.

Background material and case study data from kerbside collection trials and the evaluation of HWRC performance was used to illustrate a number of issues and from this some conclusions and recommendations may be made:

- Having a clear knowledge and understanding of existing waste characteristics and composition is fundamental to forecasting future recycling rates for different collection and waste processing options;
- Developing a modelling and analysis tool to help understand waste flows and to predict recycling rates is vitally important if integrated waste management is to play an effective role in promoting sustainable waste management;
- For the example given in this Chapter, introducing extensive kerbside collection of green waste (not including kitchen waste) could contribute significantly to meeting national recycling targets. However, care should be taken to ensure that additional waste is not created or simply diverted from other recycling routes. Enhancing existing facilities and/or promoting waste minimisation through home composting might be a cost-effective alternative to the introduction of free kerbside collection schemes. Prohibiting green waste in residual waste collections is likely to enhance HWRC use. Charged kerbside collections may offer an opportunity of increasing green waste collected whilst minimising green waste diversion from HWRC and home composting;
- When considering different options, within an integrated waste management framework, regard should be given to building on existing recycling services and enhancing current waste minimisation activities. Exploring ways of combining services and introducing multiple approaches to recycling should also be considered.

Chapter 9 — The Use of Modelling in Residual Waste Management Strategies

9.1 Introduction

Integrated solid waste management (IWM) is generally considered to be a waste management system where the individual components of the waste stream are treated in the most appropriate manner with regard to resource conservation, environmental impacts and cost. While few individuals or organisations would argue against IWM in principle, the question is often asked whether it works in practice. For example, there is concern that the existence or an energy recovery plant will divert waste from recycling and that the residue from intensive recycling schemes will not be suitable for energy recovery. Issues such as balancing the demands of composting with the introduction of mechanical biological treatment processing or anaerobic digestion for the residual waste may also need to be dealt with in strategic planning for IWM.

This Chapter addresses these issues in general terms by considering the physical, chemical and biological composition of the material comprising each component of the municipal solid waste (MSW) stream. Physical composition was discussed in detail Chapter 6, with particular focus on the composition of household waste with a view to its potential for recycling – what materials can be recycled and how much of them are available. What this Chapter does is explore the effects of different source segregated recycling schemes on the composition of the residual waste remaining to be processed. In this way potential conflicts and synergies between different elements of an integrated waste management system can be explored through modelling and scenarios.

The methodology used can be applied to data from any waste disposal authority wishing to explore the potential and limitations of IWM based on local data. As in previous Chapters, data from Hampshire is used as an illustrative case study.

9.2 Selected Scenarios Used to Model Waste Composition

In this Chapter, data from a number of sources are combined to model the flow of materials through the waste management system for a number of the scenarios developed in Chapter 7. The flows considered are in both physical terms (paper, glass, garden waste etc) and chemical terms (moisture, ash, carbon thermal content etc). These flows can then be used to characterise any of the material streams and their suitability for the different waste management options such as recycling, composting, combustion etc. Of particular interest is the residual waste remaining after the implementation of the various recycling collection schemes. Consideration of the physical and chemical composition of the residual waste will give an indication of the suitability of the different recovery and disposal options and whether the upstream recycling scheme allows a system of IWM to be implemented.

Details of the scenarios considered are given in Chapter 7 and the key features of each scenario are summarised in Table 9.1 below.

Table 9.1 Waste management scenarios under consideration

Scenario	Features
1998/99 baseline	Recycling through banks, some kerbside schemes and from CA sites.
1	Intensive bring sites for glass and textiles increases capture rate to 60% for these materials. No other changes.
2	Bring sites as baseline. County-wide kerbside for papers, cans and dense plastics to match Hampshire's best performing scheme.
2a	Scenario 2 plus collection of glass in kerbside scheme.
3	25% of garden waste collected in kerbside scheme with no effect on CA waste. No other changes
5	Combining scenarios 1 and 2.
6	Combining scenarios 3 and 5.
8	Scenario 4 for dry recyclables collection. 75% of garden waste and 21% of kitchen waste collected in kerbside scheme. 50% increase in garden waste (25% diversion from CA sites to the collection and 25% "new waste" from increased gardening activity and reduced home composting).

9.3 Sources of Data

9.3.1 Waste Quantities and Composition

The sources of the data used in this Chapter are summarised in Table 9.2.

Table 9.2 Principal sources of data

Data	Source
Scenarios and recycling participation	Chapter 7
Quantities of wastes produced	Chapter 6
Physical composition of household collected waste	Chapter 6
Physical composition of civic amenity waste	Chapter 6
Physical composition of litter	Milton Keynes Council (2000)
Chemical composition of waste	Environment Agency (1994)

The data used on the chemical composition of MSW are taken from the UK Household Waste Analysis Project (UKHWAP) (Environment Agency 1994). During UKHWAP samples of household-collected waste were taken from several locations across the UK, sub-sampled and sorted by a combination of mechanical and manual methods into 23 categories. Samples of the sorted material from each location were then combined, dried, size reduced and subject to proximate analysis for fuel properties (moisture, ash, fixed carbon and volatile matter), calorific value and elemental composition. This was carried out in 1992 and again in 1993. The values used in this project are the mean of the results for the two years.

The UKHWAP is the only source of information on the chemical composition of MSW, but it must be treated with caution for the following reasons.

- A rotary trommel screen was used as the first stage of the waste sorting process. The effect of this was to mix the waste so that moisture would migrate from the wetter to the

drier materials. For example, newspapers would become wet through contact with kitchen waste. There is also the potential for materials such as paper to become contaminated through contact with grit, dust, broken glass etc.

- The trommel screen is designed to separate material by size and any items passing through the screen is classed as “fine” material. This means that much of the garden waste (grass clippings for example) would be classed as “fines” rather than as “garden waste”.
- No analyses were carried out on wastes other than household-collected waste. So the analysis carried out here assumes that the chemical composition of any given component is the same regardless of the waste stream it occurs in. Taking ferrous metal as an example it would be reasonable to expect that the physical composition of “other ferrous metal” (i.e. not cans or batteries) will be different in the cases of household-collected and civic amenity wastes.
- There were some wide variations in the UKHWAP results between the years which cast doubt on their validity. For example, the lead concentrations of plastic bottles were 390 ppm and 36 ppm for the 1992 and 1993 samples respectively.

In order to develop work of this nature it is essential that further work is undertaken on the chemical composition of all components of the household waste stream using waste sampling methods and physical categories appropriate to the current needs of waste management practitioners and researchers.

9.4 Modelling Predictions for Physical and Biological Composition of Different Waste Streams

9.4.1 *Waste arisings and disposal routes for each scenario*

In any modelling exercise of this nature, the first stage involves determining where the wastes are generated, where they are collected from and how they are treated. This information is required for each scenario or waste collection and management system to be explored.

Although this is a relatively simple stage it immediately shows the importance of each part of the waste stream and the size of the processing and disposal facilities required. It also illustrates to what extent a given scenario reduces the need for landfill disposal.

In the case of the Hampshire case study this information is presented in Table 9.3 in Insert 9.1.

9.4.2 *Impact on national recovery targets*

The National Waste Strategy (DETR, 2000) sets the following targets for recycling and recovery in relation to MSW:

- to recover value from 40% of municipal waste by 2005;
- to recover value from 45% of municipal waste by 2010;
- to recover value from 67% of municipal waste by 2015;
- to recycle or compost at least 25% of household waste by 2005;
- to recycle or compost at least 30% of household waste by 2010;
- to recycle or compost at least 33% of household waste by 2015.

In this context “recovery” includes materials recycling, composting, energy recovery by incineration or anaerobic digestion. It should also be noted that the recovery targets relate to MSW whereas the recycling targets to household waste. The difference between these terms is that MSW includes commercial and industrial wastes that are collected by the local authority (or its contractors). In many areas commercial and industrial waste comprises a

significant amount of the MSW stream. However, in Hampshire the districts collect virtually no commercial or industrial waste so the two terms are synonymous.

The results from Table 9.3 can be used to calculate the recycling and recovery rates for any given scenario and the values obtained can then be compared with the waste strategy targets. Meeting recycling targets is discussed in detail in Chapter 7.

For the case study example the recycling and recovery rates for Hampshire for each scenario are shown and discussed in Table 9.4 in Insert 9.2.

The specific issues relating to the case study are considered in Insert 9.2, but in general terms it can be concluded that for any local authority to meet the recovery targets at least one of the options discussed in Section 9.6 will be required in addition to recycling and composting.

Insert 9.1: Hampshire case study – waste arisings and disposal routes

Table 9.3 shows the amount of waste generated in each of the following streams:

- refuse collection vehicle (RCV);
- civic amenity sites (CA);
- kerbside collections for recycling and/or composting;
- bring collections for recycling;
- other wastes (essentially local authority litter collections).

The table also shows the quantities of waste managed in the following ways:

- recycling;
- composting;
- landfill.

This table assumes that the whole of the non-recyclable residual waste is disposed of by landfill. The options for recovery and non-landfill disposal of the residue are considered in Section 9.6 below. However, it should be noted that, in the case study example of Hampshire, it is intended that 420,000 t y⁻¹ of the residue will be burned in three incinerators that incorporate energy recovery plant.

Table 9.3 Municipal solid waste generation and disposal routes for each scenario

Scenario	Generation						Treatment		
	Total	RCV	CA	Kerbside	Bring	Other	Recycled	Composted	Landfilled
Baseline	708,353	484,074	130,371	40,234	26,684	26,990	88,534	47,313	572,506
1	708,353	463,242	130,371	40,234	47,516	26,990	109,366	47,313	551,674
2	708,353	408,086	130,371	116,222	26,684	26,990	164,522	47,313	496,518
2a	708,353	403,189	130,371	131,813	15,989	26,990	169,418	47,313	491,621
3	708,353	469,358	130,371	54,950	26,684	26,990	88,534	62,030	557,790
5	708,353	387,254	130,371	116,222	47,516	26,990	185,354	47,313	475,686
6	708,353	372,538	130,371	130,938	47,516	26,990	185,354	62,030	460,970
8	725,758	335,248	112,966	203,038	47,516	26,990	185,354	109,386	431,018

Note: In the disposal category, materials for recycling is derived from kerbside collections, bring schemes and from the recycling carried out at CA sites.

Insert 9.2: Hampshire case study – meeting recovery targets

In this table the values shown for recovery assume that the three incinerators currently under construction in Hampshire will operate at their design capacity and process a total of 420,000 t y⁻¹.

Table 9.4 Recycling and recovery rates for each scenario

Scenario	Recycling rate (%)	Recovery rate (%)
Scenario 0: baseline - situation in 98/9	19	78
Scenario 1: high bring for glass and textiles	22	81
Scenario 2: improved kerbside collection of dry recyclables (paper, cans and dense plastics)	30	89
Scenario 2a: improved kerbside collection of dry recyclables - including glass	31	90
Scenario 3: charged kerbside collection of garden waste; dry recycling remains the same	21	81
Scenario 5: improved targeting of bring and kerbside	33	92
Scenario 6: improved targeting of bring and kerbside with charged garden waste collection	35	94
Scenario 8: improved targeting of bring and kerbside with organics collection of garden +kitchen waste	42	97

The recovery targets of 40% by 2005, 45% by 2010 and 67% by 2015 would not be met through materials recycling and composting alone, as illustrated by the recycling rates shown above for each of the scenarios. This emphasises the need for further treatment of residual wastes after source segregation if the recovery targets are to be met.

In all the scenarios considered, the final recovery rate of 67% is easily met due to Hampshire's adoption of incineration with energy recovery as part of its IWM strategy. This is assuming that the incineration capacity currently under construction is brought on stream.

Recovery targets depend not only what recycling is being carried out but also on how the residual waste collected by the authority is treated. As can be seen from the Insert, Hampshire will have no trouble reaching their recovery targets due to the incineration with energy recovery capacity they have planned

Similarly, the development of anaerobic digestion on a large scale as discussed in Section 9.6 could also enable the recovery targets to be met provided beneficial uses could be found for the digestate. Mechanical biological treatment (MBT), discussed in Section 9.6.3, is not a recovery option in its own right. However, the use of MBT in conjunction with refuse derived fuel and/or producing and using stabilised material could contribute to the recovery targets if outlets can be found for the fuel and stabilised material.

9.5 Implications for the Landfill Directive

Under Article 5 of the Landfill Directive (LFD) (EC Official Journal, 1999) the UK as a whole has to make the following reductions in the amount of biodegradable MSW (BMSW) sent to landfill.

- 75% of the amount of BMSW produced in the baseline year of 1995 by 2008
- 50% of the amount of BMSW produced in the baseline year of 1995 by 2013
- 35% of the amount of BMSW produced in the baseline year of 1995 by 2020.

BMSW is generally taken to mean the whole of the paper, card, kitchen and garden waste and 50% of the textiles, miscellaneous combustible and fine materials. Using these values and taking account of the materials separated for recycling the diversion of BMSW can be calculated for any given scenario. For the case study example, the diversion of BMSW due to recycling and composting only is reviewed in Insert 9.3.

Insert 9.3: Hampshire case study – meeting the Landfill Directive targets

The performance of each scenario against these targets is shown for the case study in Table 9.5. In these calculations it is assumed that the amount of BMSW produced in the directive's baseline year of 1995 is similar to the amount produced in 1998/99.

Table 9.5 Scenario performance against Landfill Directive requirements

Scenario	Percentage of BMSW landfilled
Scenario 0: situation in 98/9	80
Scenario 1: high bring for glass and textiles	78
Scenario 2: improved kerbside collection of dry recyclables (paper, cans and dense plastics)	66
Scenario 2a: improved kerbside collection of dry recyclables - including glass	66
Scenario 3: charged kerbside collection of garden waste; dry recycling remains the same	77
Scenario 5: improved targeting of bring and kerbside	64
Scenario 6: improved targeting of bring and kerbside with charged garden waste collection	61
Scenario 8: improved targeting of bring and kerbside with organics collection of garden +kitchen waste	49

It is apparent that, while the recycling and composting schemes will contribute to meeting the targets, some other process or combination of processes will be required to achieve the 2013 and 2020 targets. These processes include incineration, anaerobic digestion and mechanical biological treatment. These three options are considered in Section 9.6.

9.6 Implications for Processing Non-Recyclable Wastes

The previous section has reviewed possible ways of recovering materials and compost from Hampshire's MSW stream by source segregation processes. However, even the most ambitious scheme considered still leaves over 60% of the MSW remaining for disposal and does not meet the long-term requirements of the Landfill Directive.

Local authorities developing IWM strategies will need to consider the options available for treatment and disposal. It is critically important to determine how these options will work with upstream source segregation schemes and to what extent the technologies can be integrated. Options include incineration with energy recovery, anaerobic digestion (AD) and mechanical biological treatment (MBT).

The main option being taken in Hampshire is incineration, although they continue to explore AD and other options for the future. Therefore in the case study it has been important to assess the impact of the separation schemes on the quantity and quality of the incineration feedstock. This is done in Section 9.6.1 for three of the scenarios; scenario 1 with minimal segregation, scenario 5 which almost meets the national recycling targets and scenario 8 which involves the highest levels of recyclable and compostable material segregation.

In Sections 9.6.2 and 9.6.3 similarly the impact of the separation schemes on the quantity and quality of the feedstock for the two processes of anaerobic digestion and mechanical biological treatment (MBT) are considered. This uses a combination of the information on the quantities and types of material diverted from the residual waste through collections for recycling or composting and the chemical compositional information from UKHWAP.

9.6.1 *Energy from Waste*

Table 9.6 in Insert 9.4 summarises the combustion-related properties of the residual waste stream predicted by the scenarios for the case study. It shows that the upstream separations for recycling and composting have no detrimental impact on the quality of the waste in terms of its fuel properties. This is in line with the findings of similar research (Atkinson *et al* 1995).

There is a slight increase in the moisture content of the waste in scenario 5 due to the preferential separation of large quantities of relatively dry paper. In scenario 8, the additional removal of compostable material partially compensates for this effect, but the reduction in paper still predominates. The calorific value increases with increasing recycling. This is principally due to the relatively small proportion of high-calorific value plastic that is removed by recycling schemes.

Insert 9.4: Hampshire case study – impacts of scenarios on incineration feedstock and capacity

Feedstock quality:

The key combustion-related properties of the residual RCV waste are summarised in Table 9.6.

Table 9.6 Combustion-related properties of residual RCV waste

	Scenario 1	Scenario 5	Scenario 8
Mass (t)	463,200	387,300	335,200
Moisture content (%)	33	39	37
Ash content (%)	17	20	21
Carbon content (%)	22	23.4	24
Calorific value (MJ kg ⁻¹)	9.36	10.0	10.3
Thermal content (GJ)	4,335,000	3,873,000	3,453,000

Section 9.5 has shown that recycling and composting alone are highly unlikely to provide sufficient diversion of BMSW from landfill to allow compliance with Article 5 of the Landfill Directive and meet the diversion targets. Knowledge of the composition of the residual waste allows the calculation of the incineration capacity necessary to ensure Landfill Directive compliance. This is discussed in Insert 9.5 for the Hampshire case study.

Table 9.7 of Insert 9.5 shows the additional amount of BMSW that must be diverted from landfill to allow the 2020 diversion target to be achieved for the three scenarios. The table also shows the BMSW content of one tonne of residual waste for each of the scenarios and the incineration capacity required by each scenario to comply with the Directive.

In assessing the incineration of the residual waste it is important to consider the total tonnage of residual waste available. This is important for authorities that are proposing to build new incineration plant, because an excess capacity could lead to any combination of:

- the importing of waste from neighbouring authorities;
- increased operational costs;
- a reduction in recycling provision.

All these options are likely to be politically unacceptable and could also lead to an environmentally sub-optimum solution. In practice, given that the diversion rates achieved from composting and recycling, this problem would only arise for authorities that burned over 60% of their municipal waste.

Authorities that already operate incinerators (or have capacity under construction) face similar potential problems. However, this would also only apply to authorities with a very high commitment to incineration. This is considered for the case study example in Insert 9.6 where the only problem would be to organise CA site operation to allow suitable non-recyclable wastes delivered to the CA sites to be diverted for incineration rather than to landfill disposal.

Insert 9.5 Hampshire case study – the use of incineration to meet the Landfill Directive diversion targets

Table 9.7 The use of incineration to meet the Landfill Directive

	Scenario 1	Scenario 5	Scenario 8
Additional BMSW diversion required (t)	208,300	148,100	79,600
Amount of BMSW diverted per tonne processed (t)	0.693	0.657	0.629
Incineration capacity required (t)	300,600	225,400	126,600

This demonstrates a need for incineration capacity of 127,000 – 300,600 tonnes per year. However, Hampshire's forthcoming capacity of 420,000 tonnes per year should be taken as a sign of prudence rather than excess for the following reasons:

1. This analysis ignores any growth in MSW production. Whilst the County and District authorities are involved in several initiatives to reduce MSW generation increases in waste production cannot be ruled out due to factors such as increasing population and the increase in single person households. Even a modest annual increase becomes significant over the 20 plus year timescale of the Directive (a 1% annual growth rate would result in a 22% increase in waste over 20 years).
2. IWM is not just about meeting targets, it is also about conserving landfill capacity. Many counties have only a few years capacity remaining and, under the proximity principle, the potential for exporting waste to neighbouring or distant counties will be reduced in the future.
3. The Government intends to apply the Directive by means of a system of tradable permits. Under such a system, counties that over-achieve the targets will be in a position to sell their excess landfill allocation (with money and not waste changing hands). Depending on how the system operates, this could be financially attractive to counties that are able to sell parts of their allocation.

Insert 9.6: Hampshire case study – feedstock quality in relation to capacity under construction

Table 9.6 indicates that for scenarios 5 and 8 the amount of household-collected waste available for incineration is less than the total design capacity of the three incinerators. However, there is nothing to prevent the remaining capacity being made up by diverting some of the litter and CA waste from landfill to incineration. This is common practice and several UK incinerators do incorporate CA sites which provide some of the incinerator feedstock.

The characteristics of the feedstocks for the three scenarios are shown in Table 9.8.

Table 9.8 The use of CA waste and litter to provide incineration feedstock

	Scenario 1	Scenario 5	Scenario 8
Feedrate (t y ⁻¹)			
RCV	0	380,000	350,000
CA	0	40,000	55,000
Litter	0	0	15,000
Total	420,000	420,000	420,000
Moisture (%)	33	39	37
Ash (%)	17	20	22
Carbon (%)	22	23	23
Calorific value (MJ kg ⁻¹)	9.0	9.7	9.9
Thermal input	3,930,123	4,079,234	4,165,486

The only significant difference in the three cases is the 10% increase in calorific value (and related 6% increase in thermal input) between scenarios 1 and 8. Given that incinerators are designed to handle a given thermal input, this means that in reality the amount of CA waste and litter sent for incineration would be less than this table suggests.

9.6.2 Anaerobic Digestion (AD)

Anaerobic digestion (AD) treats biodegradable wastes by bacterial action in the absence of oxygen at high moisture contents. The products are biogas (a mixture of methane and carbon dioxide) and digestate (a slurry that can be dewatered to give a solid product similar to compost). AD is widely used to stabilise sewage sludge and there have been limited trials using source-segregated garden and kitchen waste in the UK. However, there is no large-scale experience of treating mixed MSW by AD. Globally there were around 10 plants using mixed MSW in 2000.

In this Report, we are assuming that AD would be considered as a means of treating the residual waste rather than source segregated material. A number of processes are offered by suppliers which are broadly similar in nature. The feedstock is subject to a combination of screening, size reduction and other separation stages. This product is then slurried with water and fed to the digester. Digestion takes place over a two-four week period at a controlled temperature. After digestion, the slurry may be dewatered to form a cake that is composted and then used as low-grade soil conditioner or as landfill cover material (source-segregated feedstocks allow higher grade uses of the product). Alternatively, the slurry itself may be spread on agricultural land where it does have some benefits in terms of organic material and nutrient (especially nitrogen) addition.

Bates and Wheeler (2000) have suggested values for the proportions of each category in the waste that would report to the digester feedstock. Their values were based on research carried out at the former Warren Spring Laboratory and on discussions with AD plant operators. In the following analysis carried out using the case study data these figures are used. We have also made the following assumptions:

- the fraction of the waste rejected in the feed preparation process is landfilled;
- a beneficial use is found for the digestate that allows it to count towards the landfill directive diversion targets.

The percentage of each material in MSW that is used in the AD process is given in Table 9.9.

Table 9.9 AD process acceptance rates

	Percentage accepted by		
	Feed preparation plant	AD process	Overall recovery factor
Paper and card	75	90	67.5
Plastic film	5	5	0.3
Dense plastic	5	5	0.3
Textiles	5	5	0.3
Misc. combustible	15	5	0.8
Misc. non-combustible	60	5	3.0
Glass	90	5	4.5
Ferrous metal	5	5	0.3
Non ferrous metal	5	5	0.3
Putrescible	75	95	71.3
Fines	100	40	40.0

AD does have the potential for diverting BMSW from landfill while producing a potentially useful digestate product and exporting some useful energy. However, large-scale long-term trials are needed to prove the technology with mixed MSW. Such trials would also allow the digestate to be characterised and its potential for beneficial use to be assessed from the technical environmental and financial standpoints. Until such trials are carried out, the true potential for AD cannot be determined.

Insert 9.7 considers the scope for AD to treat the residual waste for the case study example. This analysis suggests that AD can meet the landfill directive requirements, but only in combination with a county-wide collection scheme for recyclable and compostable waste. AD would also allow the national MSW recovery target to be met. It should be noted that AD is an emerging technology in the UK and is yet to be proven.

Insert 9.7: Hampshire case study – feedstock quality and capacity needed to ensure Landfill Directive compliance with AD

Applying the AD process acceptance rates values to the residual waste produced in each of the scenarios allows Table 9.10 to be constructed for a notional AD plant feedrate of 100,000 t y⁻¹.

Table 9.10 AD process effectiveness

	Scenario 1	Scenario 5	Scenario 8
Input to digester (t)	45838	43215	40945
BMSW content (t)	44553	41686	39292
Feed rejects to landfill (t)	54162	56785	59055

Combining these results with the degree of BMSW required to meet the directive gives the AD plant capacity required for the three scenarios as shown in Table 9.11

Table 9.11 The use of AD to meet the Landfill Directive

	Scenario 1	Scenario 5	Scenario 8
BMSW diversion required	208,300	148,100	79,600
Digestion capacity required (t)	467,500	355,300	202,600
RCV total (t)	463,200	387,300	335,200
Percentage of RCV waste to be treated	101	92	60

This demonstrates that AD is less effective than incineration in treating the residual waste. This is due to the fact that over half the residual waste is unsuitable for digestion. For the low recycling scenario 1, it can be seen that AD would not achieve the 2020 BMSW diversion target. However, this would be possible when combined with the county-wide kerbside collection of recyclable material and kitchen and garden wastes.

One factor in common with the incineration option is that the recycling scenarios influence the quantity of residual waste available for processing, but have only a minor impact on the suitability of the material for AD (as demonstrated by the proportion of waste rejected from 54% in scenario 1 to 59% in scenario 8).

9.6.3 Mechanical Biological Treatment (MBT)

Mechanical biological treatment (MBT) is a method for stabilising mixed waste in a crude composting operation that may be preceded or followed by a range of physical processes designed to extract recyclable materials or compost from the waste. The technology is closely based on the refuse-derived fuel (RDF) processes developed in the 1970s. In fact, one potential use of MBT is to produce a RDF for use in dedicated combustion plant.

During the composting stage the overall mass of the material is reduced by around 25% due to the evaporation of moisture and the release of carbon dioxide and additional water as the organic material breaks down.

As well as fuel, other possible uses of the product are as a crude soil conditioner in land remediation or construction products. In the absence of outlets of this nature, it is likely that the product will be used as landfill cover material.

There is some debate over the status of MBT residue in terms of the Landfill Directive. It is possible that the stabilised material may be landfilled without being classed as “biodegradable”. On the other hand, this may not be the case. Clarification is necessary in

the form of experimental studies and the opinion of the Environment Agency (or other appropriate national regulator) should be obtained.

However, in this Report it is assumed that the waste treated by MBT is either used in a beneficial way (fuel or soil conditioner) and that this use does count towards the Landfill Directive targets. It has also been assumed that the feed preparation process is similar to that used for the AD process with the following efficiencies for the separation of each material.

Table 9.12 MBT process acceptance rates

Category	Proportion entering MBT process
Paper and card	75%
Plastic film	75%
Dense plastic	50%
Textiles	50%
Misc. combustible	20%
Misc. non-combustible	60%
Glass	90%
Ferrous metal	5%
Non ferrous metal	5%
Putrescible	75%
Fines	100%

For the case study example, Insert 9.8 considers the potential of MBT of meeting the landfill directive. The results suggest that MBT would allow the landfill directive requirements and national recovery target to be met providing that the end-products can be used.

Insert 9.8 Hampshire case study – feedstock quality and capacity needed to ensure Landfill Directive compliance with MBT

On the basis of the above assumptions, the effect of subjecting a notional 100,000 tonnes per year of residual waste to the MBT process is given in Table 9.13.

Table 9.13 MBT process effectiveness

	Scenario 1	Scenario 5	Scenario 8
Input to MBT process (t)	67,178	66,866	66,208
BMSW content (t)	50,589	47,616	45,403
Feed rejects to landfill (t)	32,822	33,134	33,792

Combining these results with the degree of BMSW required to meet the directive gives the MBT plant capacity required for the three scenarios as shown in Table 9.14

Table 9.14 The use of MBT to meet the Landfill Directive

	Scenario 1	Scenario 5	Scenario 8
BMSW diversion required	208,300	148,100	79,600
MBT capacity required (t)	411,800	311,000	175,300
RCV total (t)	463,200	387,300	335,200
Percentage of RCV waste to be treated	89	80	49

Although the MBT process is still not as effective as incineration in diverting BMSW from landfill, it would be possible to comply with the Landfill Directive diversion targets using any of the recycling scenarios in combination with MBT. However, this does assume that a beneficial use for the MBT material can be found – something that has still to be demonstrated in the UK.

9.7 Conclusions

Combining data on the quantity of material in each component of the MSW stream with the physical and chemical composition of each component allows different waste management scenarios to be modelled. This modelling can assess the schemes in terms of their compliance with national and local recycling and recovery targets and with the Landfill Directive diversion targets.

Compliance with recycling targets was discussed in Chapter 7, with the focus of this Chapter being on meeting the recovery targets and the effects of recycling and composting schemes on the composition of residual waste and its consequent suitability for further processing to recover value. The modelling described here allows the effect of recycling and composting schemes on the characteristics of the residual waste to be determined.

For the case study area of Hampshire a modelling exercise has shown that:

- the national recovery target of 67% can only be met through the implementation of a scheme to recover energy or materials from the residual waste;
- the maximum recycling and composting rate from recycling and composting predicted through the scenarios is likely to be around 40%, and hence could not meet longer term recovery targets alone;
- the intensive recycling schemes proposed in the scenarios do not adversely affect the properties of the residual waste in terms of its suitability for incineration, anaerobic digestion (AD) or mechanical biological treatment (MBT);
- incineration of a proportion of the residual waste will allow the Landfill Directive diversion targets to be met regardless of the recycling scheme in place;
- MBT of a proportion of the residual waste will also allow the Landfill Directive diversion targets to be met regardless of the recycling scheme in place. However, this assumes that a beneficial use (fuel or land remediation) can be found for the end product of the MBT process.
- AD will only allow the Landfill Directive diversion targets to be met when used in combination with a county-wide collection scheme for recyclable and compostable materials.

It should though be noted that AD and MBT are generally not considered to be in a position yet to be regarded as tried and tested technologies for treating MSW. Large scale trials of AD and MBT should be established to assess these technologies for treating MSW in the UK.

This Chapter clearly demonstrates the usefulness of this type of modelling and composition analysis in planning IWM systems. It has however had to rely on insufficiently reliable data, and hence recommends the need for a research programme to determine the physical and chemical composition of all parts of the MSW stream. Such a programme should be commissioned by the Environment Agency and/or DEFRA to replace the decade-old data used in this Report.

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Glossary of Acronyms

AD	Anaerobic digestion
AWP	Area waste plan
BPEO	Best practicable environmental option
BVPI	Best value performance indicator
CA site	Civic amenity site
CC	County council
CIWM	Chartered Institute of Wastes Management
DEFRA	Department of the Environment, Food and Rural Affairs
EA	Environment Agency
EI	Environmental impact
EfW	Energy from waste
GIS	Geographical information systems
HCC	Hampshire County Council
HWRC	Household waste recycling centre
IWM	Integrated waste management
IWS	Integrated waste systems
LCI / LCA	Life cycle inventory / life cycle analysis
LFD	Landfill Directive
MBT	Mechanical and biological treatment
MWM	Municipal waste management
NAW	National Assembly for Wales
NAWDO	National Association Waste Disposal Officers
NRM	Natural resource management
NWS	National waste strategy
RCV	Refuse collection vehicle
RDF	Refuse derived fuel
SAG	Strategy area group
SEPA	Scottish Environmental Protection Agency
SWAG	Scottish waste action group
SWMBA	Strategic waste management baseline assessment
UA	Unitary authority
UKHWAP	UK Household waste analysis project
WCA / WDA	Waste collection authority / waste disposal authority
WSA	Waste strategy area
WLP	Waste local plan

Appendices

Appendix 1: Local Authority Waste Management Plans and Strategy Documents:

The list below gives details of web-site addresses for the authorities whose strategy documents have been reviewed in this Report, and references specific reports used in this research

Hampshire CC / Project Integra	<p>Project Integra's web-site: www.integra.org.uk</p> <p>Hampshire CC web-site: www.hants.org.uk/hcc/index.html</p> <p>PI strategy documents: 'Your Waste Your Solution' (1997); 'Dealing with Hampshire's Waste - The Proposed Solution' (1995); 'Dealing with Hampshire's Waste - The Way Forward' (1993)</p>
Medway	<p>Medway Council's web-site: www.medway.gov.uk</p> <p>'Medway Waste Strategy' (1999)</p>
Surrey	<p>Surrey CC's web-site: www.surreycc.gov.uk</p> <p>'Surrey Waste Local Plan 1997'</p> <p>Surrey Waste Management Ltd web-site: www.surreywaste.co.uk which also provides information on WM in Surrey</p>
Milton Keynes	<p>Milton Keynes Council web-site: www.mkweb.co.uk/environment</p> <p>'House Waste Composition Study: April and November 2000' Milton Keynes Council</p> <p>'A Waste Strategy for Milton Keynes: October 2002 Update' Milton Keynes Council</p>
Essex	<p>Essex CC web-site: www.essexcc.gov.uk/waste_management.asp</p> <p>'A Municipal Waste Management Strategy for Essex, Southend and Thurrock' ERM, Sept 2002</p>
Cambridgeshire and Peterborough	<p>Cambridgeshire web-site: www.camcnty.gov.uk</p> <p>Peterborough web-site:</p> <p>'Towards a Waste Strategy – why we need a strategy for the waste we all produce' and 'The Rubbish Consultation – What you said', 2001 (www.camcnty.gov.uk/sub/consult/rubbish/)</p> <p>'Towards a Waste Management Strategy: Cambridgeshire and Peterborough Joint Waste Management Strategy' Consultation document, 2001</p> <p>'Data Group – Draft Background Report' Cambridgeshire and Peterborough Joint Waste Data Sub Group, 2000</p>
Bristol	<p>Bristol City Council's web-site: www.bristol-city.gov.uk</p> <p>Mansell D (2001)'Bristol Recycling Participation Study: summary report for The Recycling Consortium' The Recycling Consortium, Bristol</p> <p>'Draft Household Waste Management Strategy: Technical Version' Bristol City Council (1999)</p>
Cornwall	<p>Web-sites: www.cwwg.co.uk & www.cesgroup.co.uk & www.greenpark-cornwall.com & www.cornwall.gov.uk/Environment/recycle</p> <p>AEA Technology (2001)'An Environmental Assessment of Some Options for the Treatment of Municipal Solid Waste' A report produced for Cornwall County Council</p> <p>'Cornwall Local Waste Plan: Revised Deposit Draft' 2001</p> <p>'A fresh look at Cornwall's waste' Cornwall's Waste Working Group, 1999</p> <p>'Cornwall's plan for putting waste to work: Greenpark Cornwall' County Environmental Services (cesgroup)</p>

Gloucestershire	Gloucestershire CC web-site: www.gloscc.gov.uk 'Waste Management Strategy' Gloucestershire CC (1997) Waste Local Plan (pre-deposit consultation draft) Gloucestershire CC (2001)
Hounslow	Hounslow Council's web-site: www.hounslow.gov.uk/environmental/recycling has information on recycling and composting services 'Draft Version: A Waste Management Strategy for Hounslow' 2000 'Recycling Plan' 1999
Lambeth	London Borough of Lambeth web-site: www.lambeth.gov.uk 'Lambeth Waste Recycling Plan 2000-2005'
Greater London Authority	GLA web-site: www.london.gov.uk & www.london.gov.uk/mayor/strategies 'Summary: Towards a London Plan' Mayor of London, GLA, May 2001 'The Mayor's Draft Municipal Waste Management Strategy' GLA, July 2001
Staffordshire and Stoke-on-Trent	Staffordshire CC's web-site: www.staffordshire.gov.uk 'Staffordshire and Stoke-on-Trent Draft Waste Planning Strategy 1998-2011' 'Staffordshire and Stoke-on-Trent Waste Local Plan 1998-2011 Revised Deposit Draft'
Birmingham	Birmingham Council's web-site: www.birmingham.gov.uk 'Birmingham City Council Waste Management Strategy Jan 2000'
Hereford and Worcester	Worcestershire CC web-site: www.worcestershire.gov.uk/home/index/cs-index/cs-waste-management.htm 'Integrated Waste Management System' Hereford and Worcester Council's Strategy for 1998-2023 – relates to contract signed with Severn Waste Services
Cleveland	Stockton BC's web-site: www.stockton-bc.gov.uk/serv/serv-frames-wms.htm 'Joint Waste Management Strategy for Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Borough Councils' (2001)
Durham (including Sunderland and Darlington)	Durham CC web-site: www.durham.gov.uk 'Waste Strategy Jan 2001' 'County Durham Waste Local Plan Jan 2002 First Deposit Draft'
Doncaster	Doncaster Metropolitan BC web-site: 'Waste Management Strategy Consultation Draft Mar 2001' Environment, Health and Housing, Doncaster Metropolitan BC
Manchester	Greater Manchester Authorities web-sites: http://www.agma.gov.uk www.tameside.gov.uk www.oldham.gov.uk and www.trafford.gov.uk/content/sse/envservices/recycling/ 'Greater Manchester Joint Recycling Plan (Consultation Draft)' Greater Manchester Authority, 2000
Cheshire	Cheshire CC web-site: www.cheshire.gov.uk/waste 'Cheshire Joint Integrated Household Waste Management Strategy' consultants report from AEA Technology, 2001 to form basis of strategy – detail of report not published 'Our Waste Our Challenge' Waste Management Strategy 2000 Public Consultation and results of consultation, 2000
Argyll and Bute	'No Option But Change: Argyll and Bute Draft Area Waste Plan' SEPA, 2001 see also SEPA web-site: www.sepa.org.uk
Forth	'No Option But Change: Forth Valley Draft Area Waste Plan' SEPA, 2001
Fife	'Waste – Your valuable Resource or Someone Else's Problem? Fife Area Waste Plan Issues Paper' SEPA 2001

International examples:	
Barcelona, Spain	<p>'Metropolitan Plan for Urban Waste Management - for 1997-2006' Barcelona Metropolitan Environmental Authority (EMMA)</p> <p>'2000 Annual Report on Progress' Metropolitan Waste Agency, Barcelona, 2001</p> <p>EMMA web-site: www.ema-amb.com/english</p>
Dublin, Ireland	<p>'Preventing and Recycling Waste: Delivering Change: a policy statement by the National Waste Management Board (NWMB)' Department of the Environment and Local Government, Dublin Ireland, March 2002</p> <p>'Dublin Waste Management Plan 1998' Dublin Local Authorities, 1998</p>
Donegal, Ireland	'Waste Management Plan Oct 2000' Donegal County Council
London, Ontario, Canada	<p>'Continuous Improvement System for Waste Management' London Municipal Council, Ontario, Canada 1997</p> <p>'Summary report on solid waste management' London Municipal Council, Ontario, May 2000</p> <p>web-sites: www.city.london.on.ca and www.rco.on.ca</p>
Nova Scotia, Canada	<p>'Solid Waste Resource Management: A Strategy for Nova Scotians' Nova Scotia Department of the Environment, 1995</p> <p>'Status Report 2001 of Solid Waste Resource Management in Nova Scotia' Nova Scotia Department of the Environment, 2001</p> <p>web-sites: www.gov.ns.ca/enla/emc/wasteman</p>
Edmonton, Canada	<p>Edmonton Waste Management Strategic Plan.</p> <p>'Waste Management Branch Annual Report 1999' The City of Edmonton, Canada</p> <p>web-site: www.gov.edmonton.ab.ca/am_pw/waste_management</p>
Canberra, Australia	<p>'No Waste by 2010: A Waste Management Strategy for Canberra' Department of Urban Services, ACT (Australian Capital Territory) Government, 1996</p> <p>web-site: www.act.gov.au/nowaste/</p>
California, USA	<p>'Integrated Waste Management Board Strategic Plan: Draft' California Environmental Protection Agency, November 2001</p> <p>web-site: http://www.calepa.ca.gov and www.ciwmb.ca.gov</p>

Appendix 2: Websites for GIS and Mapping Information Sources

www.ordnancesurvey.gov.uk Ordnance Survey is a UK government agency, and their website includes information on digitized maps and GIS.

www.batholomewmaps.com Bartholomew website for digitized maps and related information

www.thepowerofgeography.com The Power of Geography website jointly sponsored by the Association for Geographic Information, the Intra-governmental Group on Geographic Information, and Ordnance Survey. The site provides a toolkit promoting the benefits of geospatial information.

www.mapinfo.com MapInfo supply GIS software and their site details a range of products and support services.

www.esri.com ESRI are suppliers of GIS software, including ArcView, and their site details a range of products and services, as well as more general information about GIS.

www.agi.org.uk Association of Geographic Information (AGI) represents all the interest groups which make up the UK geographic information community, with members drawn from most sectors of government, business, commerce and academia. AGI aims to increase the awareness of the benefits of geographic information throughout the community, and help all users of geographic information and GIS.

www.gigateway.org.uk The GIGateway site provides information and access to UK geographic information via the following three sources: data locator details accurate UK geographic information; data directory details organisation who supply geographic information products, services and data; and area search provides details on administrative data from the Office of National Statistics.

www.geo.ed.ac.uk Edinburgh University based website which provides information on all aspects of GIS as well as other useful web links. It also hosts the website for the UK's national GIS research conference (GISRUK).

Appendix 3: Further Details of Case Study of Integrating Total Household Waste Composition for Hampshire

This appendix includes extracts from “Integrated re-assessment of Project Integra compositional data: Report for Hampshire County Council and Project Integra” September 2001. This report gave detailed feedback, with accompanying spreadsheets, of the methodology derived to integrate the various data sources made available to the Open University for this research project. These data were for the different outlets for households waste, including collected wastes (both kerbside and residual) and waste taken to HWRCs. They were integrated in relation to the different methods of waste containment and different 'waste catchment' characteristics, in order to build an accurate picture of the amount and type of waste produced by households in any particular area.

Information included in this appendix includes some repetition of the explanatory detail given in Chapter 6, but only where needed to give the context for more specific data included here. References to specific operational data sources and other internal operationally specific details that are not necessary to describing the method and its results are omitted. Information in this appendix is included to supplement the main text – not to stand-alone.

9.7.1 *Summary of data sources involved in re-assessment*

Data sources include:

- Data from Project Integra’s Household Waste Research Programme including quantity and compositional analysis of residual waste and recyclables from 31 sample rounds, as detailed in a series of Excel spreadsheets and summarised in the MEL’s Report for Project Integra. This includes compositional analysis into a total of 167 waste categories, grouped into 40 major categories and then into 11 more general categories. Also included in this data is that from the survey and analysis of users visiting four of the WDAs HWRC sites.
- Hampshire C.C.’s operational data, including on a monthly basis:
 - collected household and non-household waste for each WCA/UA,
 - kerbside collected recyclables for each WCA/UA,
 - wastes at HWRC sites (recyclables by 11 categories, green waste, and residual wastes for disposal)
- Other data from Hampshire C.C. including:
 - materials from ‘bring’ sites (as determined from recycling credit returns and information sought from WCAs/UAs by the C.C.),
 - information on the allocation of HWRC site waste to each WCA/UA from Hampshire C.C.’s HWRC user survey data
 - demographic information from postcode data related to sample rounds and HWRC location
- National data for Hampshire taken from the DEFRA data set, for the WDA and WCAs/UAs on waste arisings, with particular reference to 1998/9, the base year for the household waste recycling Best Value Performance Indicators (BVPis)

9.7.2 *Consolidation of operational data*

Some of the operational data had been summarised by Hampshire County Council in a spreadsheet that was designed to provide a waste arisings summary and profile for each WCA/UA. This database was developed and built on to give an almost complete summary of both collected, bring site and HWRC wastes on a monthly basis with annual summaries for the years 1998/9 and 1999/00.

This was used as the basis for building up a more complete, integrated picture at a district level of the collected, HWRC and 'bring' site wastes.

This spreadsheet potentially provided the basis for allowing an integration of the amounts of the total collected, HWRC and 'bring' site wastes. This integration was critically dependent on the allocation of HWRC use by each district, which was provided by the county council.

The spreadsheet provides a fairly complete summary of collected, bring site and HWRC wastes on a monthly basis with annual summaries for the years 1998/9 and 1999/00, and a table of totals for each year:

Kerbside recycling – dry Bring recycling (not HWRC) HWRC recycling	Total dry recycled
HWRC green waste Collected green waste Total recycled	Total green waste recycled
RCV residual waste HWRC residual waste Other household collected waste	Total residual household waste
Total collected RCV waste Total collected waste Total HWRC waste	Total household waste

The chart (shown in fig (i)) summarises this information and shows the total amounts of each category of household waste for each district:

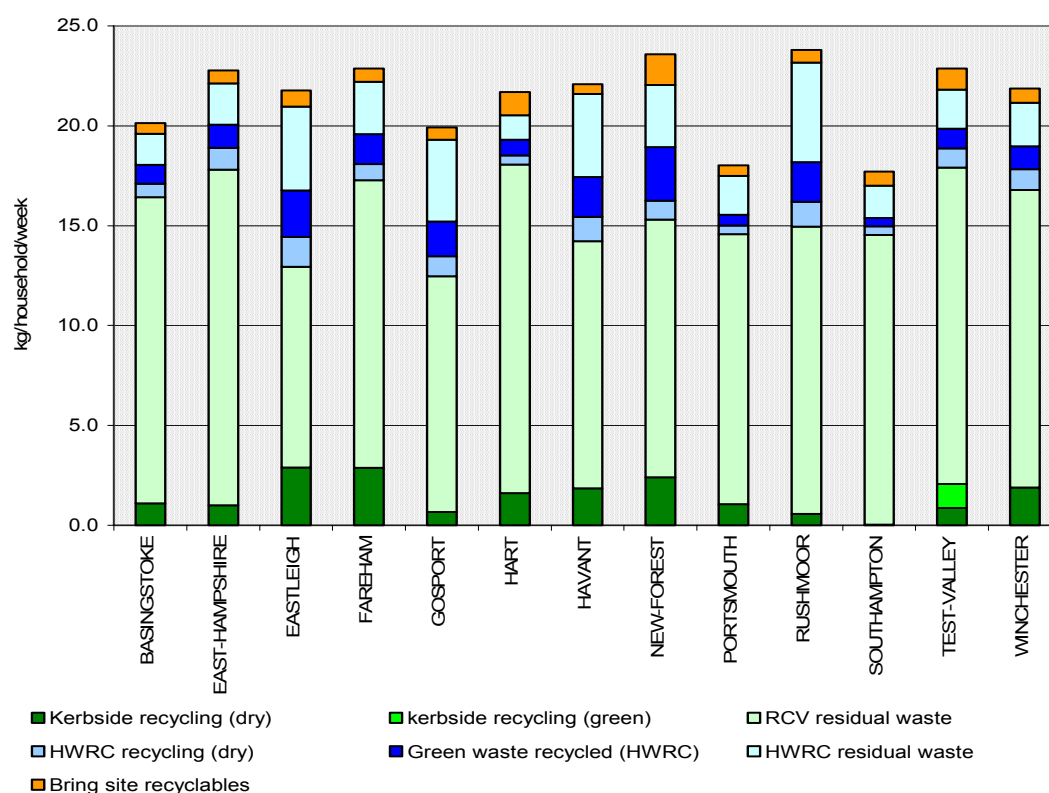


Figure (i) Household waste composition in Hampshire

9.7.3 Integrating operational data with sampled compositional data

Examining the output of this spreadsheet and the sampled collection round data for contributory factors and correlations led to a classification of districts being developed, and which was subsequently used to build an integrated district level household waste composition, using all the available data. The basis for this classification is described in Chapter 6 and additional detail only is included here.

Classification of districts for compositional analysis

Table (i) shows the relative influence of ACORN socio-economic group and high or low use of HWRC sites (in terms of quantity of waste taken to sites per household) in each WCA/UA on the average amount of collected waste (both residual and recyclables).

Table (i): Effects of HWRC use and Socio-economic group on collected household waste arisings

	low HWRC use: $\leq 5\text{kg/hhold/wk}$				High HWRC use: $> 5\text{kg/hhold/wk}$			
	sample round	total collected	green waste collected	waste in collected recyclables		total collected	green waste in collected waste	collected recyclables
ACORN groups: A+B	Bas A1	20.36	4.48	2.02	Eas A1	13.48	2.55	5.04
	Bas B4	19.80	5.09	1.71	Gos B5	12.43	4.29	0.90
	EH A1	20.53	5.17	4.96	Hav A1	10.28	2.55	2.62
	Fare A1	20.86	8.49	3.20	NF A1	9.78	2.64	2.15
	Hart A1	19.91	8.62	2.72	NF A3	12.34	3.44	3.32
	Hart B4	20.04	6.54	2.28	Rush A1	12.47	4.12	1.62
	TV A1	22.22	9.72	1.20	Rush B4	17.66	5.75	1.00
	Win A1	17.82	5.26	1.87	Rush B5	16.35	4.54	0.99
	mean	20.19	6.67	2.49	mean	13.10	3.74	2.21
ACORN groups: D+E+F	EH D9	15.82	3.19	4.51	Eas D9	14.36	2.55	4.40
	Fare D9	16.84	9.19	3.26	Gos D10	12.31	3.27	0.76
	Port D9	18.52	6.54	2.51	Gos F14	12.54	3.36	0.65
	Port D10	16.47	4.00	1.95	Hav F14	15.25	3.75	1.97
	Port E12	14.37	3.89	1.38	NF D9	10.54	4.39	
	S'ton D9	25.04	10.36					
	S'ton E11	17.62	3.25					
	S'ton F14	18.11	5.35					
	TV D9	18.14	7.96	2.92				
	Win D9	14.79	3.92	2.18				
	mean	17.57	5.76	2.67	mean	13.00	3.46	1.95

HWRC use is the factor more strongly related to the amounts of collected waste generated in an area, showing that in areas with high HWRC use that the amount of household waste collected by the WCA/UA is significantly less than when compared with areas with low

HWRC use. There is no significant effect on total collected household waste arising from the different socio-economic profiles of each area.

The effect that distance to HWRC sites might have on the amount of collected household waste generated was then considered, and plotted against the distance to nearest site for each round sampled for the MEL analysis. Again use of HWRC sites had the most marked effect, with distance not being found to be an important determinant of use, as Table (ii) shows. Access to HWRC sites is likely to be more complex than simply being dependent on distance, with car ownership and types of journeys involved also being important.

Table (ii): Effects of distance to HWRC site and its use, on collected household waste arisings

		low HWRC use: ≤ 5kg/hhold/wk				high HWRC use: > 5kg/hhold/wk			
		sample round	total collected	green waste in collected waste	collected recyclables		total collected	green waste in collected waste	collected recyclables
near to HWRC < 4miles		Win D9	14.79	3.92	2.18	Rush B4	17.66	5.75	1.00
		Port D10	16.47	4.00	1.95	Hav A1	10.28	2.55	2.62
		Port D9	18.52	6.54	2.51	Gos F14	12.54	3.36	0.65
		S'ton F14	18.11	5.35		Rush A1	12.47	4.12	1.62
		EH A1	20.53	5.17	4.96	Gos B5	12.43	4.29	0.90
		EH D9	15.82	3.19	4.51	Gos D10	12.31	3.27	0.76
		S'ton D9	25.04	10.36		Hav F14	15.25	3.75	1.97
		Port E12	14.37	3.89	1.38	Eas D9	14.36	2.55	4.40
		Win A1	17.82	5.26	1.87	Rush B5	16.35	4.54	0.99
		Fare A1	20.86	8.49	3.20	Eas A1	13.48	2.55	5.04
		S'ton E11	17.62	3.25					
		TV D9	18.14	7.96	2.92				
		Fare D9	16.84	9.19	3.26				
		mean	18.07	5.89	2.87	mean	13.71	3.67	2.00
far from HWRC >OR= 4miles		Hart A1	19.91	8.62	2.72	NF D9	10.54	4.39	
		TV A1	22.22	9.72	1.20	NF A1	9.78	2.64	2.15
		Hart B4	20.04	6.54	2.28	NF A3	12.34	3.44	3.32
		Bas B4	19.80	5.09	1.71				
		Bas A1	20.36	4.48	2.02				
		mean	20.47	6.89	1.99	mean	10.89	3.49	2.74

It was therefore decided to classify the 31 MEL samples by the extent to which their wastes were split between collected and HWRC wastes (taken from district-wide statistics derived from the operational data). The variables used in the cluster approach included total household waste, collected post-consumer waste, collected garden waste, HWRC use, and distance to HWRC site.

Table (iii) shows the results of the classification – the main characteristics of each of the four resultant cluster groups and the districts that fall into each group. There are variations in specific indicators between districts that fall into the same group as well as between rounds sampled within the same districts but the clustering process provides the best statistical match grouping of sampled rounds. The mean values obtained from each cluster can be derived to produce a compositional profile for each group of districts. Table (iv) shows this mean composition for each clustered group of districts.

This can be used together with the Hampshire operational data on total household waste arisings to generate a compositional profile for each WCA/UA's collected wastes.

Table (iii): Classification of sampled rounds into clustered groups

		sample round	ACORN group	residual waste collection method	total collected household waste (residual+ recyclables)	post-consumer waste in total collected household	garden waste in total collected household	total HWRC waste	distance to nearest HWRC site
GROUP 1	Urban group + E Hants high collected waste mostly low CA low garden waste	Bas A1	A1	Wh bin	20.36	14.35	1.50	3.22	7.5
		Bas B4	B4	Wh bin	19.80	13.25	1.75	3.22	6.3
		EH A1	A1	Wh bin	20.55	14.76	1.51	4.35	1.7
		EH D9	D9	Wh bin	15.82	11.81	0.92	4.35	1.7
		Port D10	D10	no method	16.47	11.60	1.23	2.94	0.7
	6 districts: East Hampshire Portsmouth Southampton Winchester Rushmoor Basingstoke	Port D9	D9	no method	18.52	10.87	2.39	2.94	0.7
		Port E12	E12	no method	14.37	9.77	1.13	2.94	2.2
		Ston E11	E11	Wh bin	17.62	13.41	0.57	2.46	3.2
		Ston D9	D9	Wh bin	25.04	14.06	8.60	2.46	1.7
		Ston F14	F14	Wh bin	18.11	11.10	1.10	2.46	1.4
		Win A1	A1	Wh bin	17.82	11.68	2.14	4.37	0.5
		Win D9	D9	Wh bin	14.79	10.38	1.41	4.37	2.8
		Rush A1	A1	Wh bin	12.47	7.85	2.85	8.21	1.1
		Rush B4	B4	Wh bin	17.66	11.45	2.82	8.21	0.6
		Rush B5	B5	Wh bin	16.35	11.05	2.06	8.21	2.9
	average for group 1				17.72	11.83	2.13	4.31	2.33
GROUP 2	alternating W-bin clcltns	Eas A1	A1	Wh bin	13.48	9.98	0.28	8.06	3.6
	close to CA sites	Eas D9	D9	Wh bin	14.36	10.89	0.33	8.06	2.1
	1 district: Eastleigh								
	average for group 2				13.92	10.44	0.31	8.06	2.85
GROUP 3	Wheeled bin areas	Fare A1	A1	Wh bin	20.86	11.83	6.78	4.94	3.1
	high garden waste in RCV	Fare D9	D9	Wh bin	16.84	7.47	6.66	4.94	3.6
	CA sites distant: low use	Hart A1	A1	Wh bin	19.91	10.39	6.44	2.46	4
	3 districts:	Hart B4	B4	Wh bin	20.04	13.10	4.50	2.46	4.5
	Fareham	TV A1	A1	Wh bin	22.22	11.92	6.20	3.91	3.4
	TV (kerbside compost collection)	TV D9	D9	Wh bin	18.14	9.66	5.66	3.91	4.2
	Hart								
	average for group3				19.67	10.73	6.04	3.77	3.80
GROUP 4	very low collected waste	Gos B5	B5	no method	12.43	7.49	1.47	6.83	1.5
	most plastic sack rounds	Gos D10	D10	no method	12.31	8.10	1.09	6.83	1.7
	green waste restriction in RCV	Gos F14	F14	no method	12.54	8.46	0.61	6.83	0.9
		Hav A1	A1	no method	10.28	7.20	0.38	7.36	0.8
	3 districts:	Hav F14	F14	no method	15.25	10.81	1.09	7.36	1.8
	Gosport	NF A1	A1	PS	9.78	6.44	0.92	6.78	6.5
	Havant	NF A3	A3	PS	12.34	8.42	1.33	6.78	6.9
	New Forest	NF D9	D9	PS	10.54	5.62	2.52	6.78	6.2
	average for group4				11.93	7.82	1.18	6.94	3.29

Table (iv): Compositional profile for clustered groups of districts

	Waste material categories	mean collected residual household waste (kg/hh/wk)	mean % composition of residual collected waste	mean in kerbside collected recyclables (kg/hh/wk)	mean % composition of kerbside collected recyclables
Group 1: Basingstoke, East Hants; Portsmouth; Southampton; Winchester and Rushmoor	paper and card	4.2	28%	2.0	89%
	plastic film	1.0	7%	0.0	1%
	plastic bottles and packaging	0.8	6%	0.1	5%
	textiles	0.8	5%	0.0	0%
	misc. combustibles	0.9	6%	0.0	0%
	misc. non-combustibles	0.1	1%	0.0	0%
	glass	0.7	5%	0.0	0%
	ferrous metals - food and drinks cans	0.5	4%	0.1	4%
	non-ferrous - aluminium cans and foil	0.2	2%	0.0	1%
	putrescible	4.7	31%	0.0	0%
	finest	0.8	5%	0.0	0%
	total	14.8	100%	2.2	100%
Group 2: Eastleigh	paper and card	1.9	21%	4.2	89%
	plastic film	1.0	11%	0.0	1%
	plastic bottles and packaging	0.7	8%	0.2	4%
	textiles	0.4	4%	0.0	1%
	misc. combustibles	0.7	7%	0.0	0%
	misc. non-combustibles	0.2	2%	0.0	0%
	glass	0.5	5%	0.0	0%
	ferrous metals - food and drinks cans	0.4	5%	0.2	4%
	non-ferrous - aluminium cans and foil	0.2	2%	0.0	0%
	putrescible	2.5	28%	0.0	0%
	finest	0.8	8%	0.1	1%
	total	9.20	100%	4.72	100%

Table (iv): Compositional profile for clustered groups of districts (continued)

	Waste material categories	mean collected residual household waste (kg/hh/wk)	mean % composition of residual collected waste	mean in kerbside collected recyclables (kg/hh/wk)	mean % composition of kerbside collected recyclables
Group 3: Fareham; Hart and Test Valley	paper and card	3.2	21%	2.4	58%
	plastic film	0.8	5%	0.0	1%
	plastic bottles and packaging	1.1	7%	0.1	3%
	textiles	0.6	4%	0.0	0%
	misc. combustibles	1.0	6%	0.0	0%
	misc. non-combustibles	0.2	1%	0.0	0%
	glass	0.6	4%	0.0	0%
	ferrous metals - food and drinks cans	0.5	3%	0.1	1%
	non-ferrous - aluminium cans and foil	0.3	2%	0.0	1%
	putrescible	6.9	45%	1.4	35%
	finest	0.4	3%	0.0	0%
	total	15.6	100%	4.1	100%
Group 4: Gosport; Havant and New Forest	paper and card	2.0	21%	2.2	87%
	plastic film	1.0	11%	0.0	1%
	plastic bottles and packaging	0.6	7%	0.1	5%
	textiles	0.4	4%	0.0	0%
	misc. combustibles	0.6	6%	0.0	0%
	misc. non-combustibles	0.1	1%	0.0	0%
	glass	0.6	6%	0.0	0%
	ferrous metals - food and drinks cans	0.4	4%	0.1	5%
	non-ferrous - aluminium cans and foil	0.1	1%	0.0	1%
	putrescible	3.1	33%	0.0	0%
	finest	0.5	6%	0.0	0%
	total	9.40	100%	2.51	100%

9.7.4 Allocation and composition of Civic Amenity site wastes

Quantities of CA site wastes are recorded in the Hampshire operational data as 11 recycled material categories, green waste and residual waste for each HWRC site. HWRC site use patterns, provided by the council and shown in Table (v), allowed allocation of these amounts of waste to each district and thereby an average per household established.

Research undertaken, sampling wastes brought to 4 HWRC sites provided an average compositional profile of these wastes – as shown in Table (vi).

This compositional profile was then applied to the district or per household amounts of HWRC waste. The resultant data was then integrated with the collected and bring site waste data to give an overall profile of each districts total household waste stream composition – as detailed in Chapter 6.

Table (v): HWRC site use by District

HWRC site	source of waste												
	Basingstoke and Deane	East Hampshire	Eastleigh	Fareham	Gosport	Hart	Havant	New Forest	Portsmouth	Rushmoor	Southampton	Test Valley	Winchester
Aldershot										90%			10%
Alresford													100%
Alton		100%											
Andover	10%											90%	
Basingstoke	100%												
Bishops Waltham													100%
Bordon		95%											5%
Timsbury											5%	95%	
Southampton											100%		
Eastleigh			90%									10%	
Pennington								100%					
Fair Oak			90%										10%
Farnborough										85%			15%
Gosport					100%								
Hart						95%							5%
Havant							75%		20%				5%
Hedge End			90%								5%	5%	
Hayling Island							100%						
Marchwood								80%			20%		
Netley			75%								25%		
Paulsgrove				20%					80%				
Petersfield		85%											15%
Ringwood								70%					30%
Warash				100%									
Waterlooville		10%					80%						10%
Winchester												10%	90%

Table (vi): Compositional profile for HWRC wastes

Waste material categories	mean in HWRC waste (kg/hh/wk)	mean % composition of HWRC waste
paper & card	0.22	6%
dense plastics	0.05	1%
textiles	0.10	3%
glass	0.09	2%
cans	0.33	8%
garden waste	1.84	45%
residual & other unclassified	0.87	22%
other HWRC recycled (oil, batteries + bric-a-bac)	0.07	2%
wood	0.47	12%
total	4.05	100%